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TRANSIT TRAVEL CHARACTERISTICS IN EDMONTON AND THE IMPACT OF LIGHT RAIL TRANSIT

by

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A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
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J. J. Ball
Supervisor

Date JANUARY 9, 1985

To

Patricia, Lawrence and Lillian

ABSTRACT

This thesis studies and serves to isolate trends in transit travel characteristics over a ten-year time interval. In particular, it addresses the problem facing the transportation planner when he sets out to evaluate the effectiveness of a transportation system improvement. The problem is usually compounded by the lack of a suitable and chronologically organized database.

This study is a neighborhood-level aggregate analysis, based on Edmonton Civic Census information and origin-destination data from the years 1971, 1976 and 1981. The most important transportation system improvement in Edmonton during this time period was the opening of the North East Light Rail Rapid Transit Line in April, 1978. This line was implemented as an integral part of the existing transit network in Northeast Edmonton and the focus of this study is to assess the impact of this improvement.

The investigated parameters included the number of work trips by mode, mode split, scheduled transit travel time, bus stop density and zonal demographics. The study was limited to the analysis of morning peak period work trips between selected study area origins and downtown and/or university area destinations.

The techniques used to identify trends in transit travel characteristics include regression analysis, the analysis of regression scattergram envelopes, the presentation of statistics on a geographic base, time series comparisons and control area comparisons amongst study areas and study area subsets. The use of graphic and cartographic presentation has been emphasized and has proved to be an effective research tool.

Regression analysis has proved that of the parameters tested, scheduled transit travel time and average household income have the best linear interrelationship with mode split. Cartographic presentation has shown that high mode split areas are generally located along major transit corridors or transit centers. During the time period 1976-1981, morning peak work trip mode split from the northeast study area showed a net increase of 5-7% over an area that is without light rail transit influence.

The implementation of light rail transit has significantly reduced transit travel times to major destination areas and there is evidence to suggest that this sytem upgrade has influenced morning work trip mode choice.

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LIST OF ABBREVIATIONS

CAD - Computer-Aided Design

CBD - Central Business District (Traffic Zones 12 and 14)

CENT - Central Area (Traffic zones 11, 12, 13, 14, 21, 22, 31 and 32)

CORR. - Correlation Coefficient

EMP. - Employees

HSEHLDS. - Households

km - Kilometer

L.R.T. - Light Rail Transit

METRO - Metropolitan

M.E.T.S. - Metropolitan Edmonton Transportation Study

MSE - Mean Squared Error

N.E. - Northeast

P.L.U.S. - Population and Land Use System

POP. - Population

S.W. - Southwest

UNIV. - University of Alberta/Health Sciences Area (Traffic Zones 603 and 604)

U.T.P.S. - Urban Transportation Planning System

1.0 INTRODUCTION

1.1 Problem Statement

Increasing urban travel demand usually results in an upgrading of transportation systems and facilities. In every urban center, economic growth and the outward expansion of residential development places strain on the existing transportation facilities which lead to major destination zones. A transportation planner must therefore be able to recognize trends in travel behavior and predict the probable impact of residential and economic growth. After a need for improvement has been recognized and a transportation system has been upgraded, it is beneficial to assess the impact of the system improvement. This impact assessment should be thought of as a measurement of the response of the urban traveller to his or her new transportation system.

The problem is, therefore, how does the transportation planner measure the effectiveness or impact of his transportation system improvement?

The isolation of trends in travel characteristics is a formidable task probably best suited to a disaggregate analysis over discrete time intervals. Civic census information is a readily available source of transportation-related data, but an aggregate analysis tends to "blend" and mask individual travel characteristics, thereby introducing a reliability problem. Unless an urban centre is prepared to introduce a regular schedule of disaggregate analyses, an aggregate analysis of census information provides the base for the identification of trends in urban travel characteristics.

Once trends in transportation-related parameters are discovered, the problem converts to one of asking if the trend is system-related or a function of demographic and/or economic change.

1.2 Research Objective

The objective of this thesis is to study trends in transit travel characteristics and, in particular, assess the impact of the implementation of light rail transit in Edmonton.

In order to provide a reliable analysis this study must consider the following general guidelines:

(i) The analysis should include a time segment which adequately depicts pre-L.R.T. and post-L.R.T. periods.

(ii) The time segment should include a period when economic growth rates are relatively constant.

(iii) An aggregation level should be chosen at a small enough level to ensure that the masking of individual neighborhood behavior is minimized.

1.3 Scope

The basic unit used in assessing transit travel characteristics is the transit trip. This introduces the concept of trip purpose and how trip purpose affects transportation system demand. It is well known that transit demand is heaviest during weekdays in the morning and afternoon peak hours. This demand is consistent with work trip movement. Work trips have, in the past, been defined to include trips by post-secondary students and have been found to comprise approximately 75% of morning peak hour trips (City of Edmonton Transportation Management-TSR/62/84, 1984). The stability and regularity of the work trip in the morning peak period has made it popular in work trip modelling. For this reason, this research will utilize morning peak period work trips in its analysis.

Geographically speaking, an analysis of the entirety of Metropolitan Edmonton would be too extensive given the time available for this study. The analyses in this research are limited to three study areas:

(i) Northeast Edmonton - directly under the influence of L.R.T. development.
(ii) West Edmonton - not currently under the influence of L.R.T.; a control area
(iii) Southwest Edmonton - not currently under the influence of L.R.T., but scheduled for planned L.R.T. development.

The third limit imposed is that of work trip destination. In this research, only three major destination areas will be considered:

(i) The Central Business District

(ii) The Central Area - which includes the Central Business District; but also the Government Centre and the area inbetween.

(iii) The University and Health Sciences Center.

The study areas and major destination zones are discussed in detail in Section 3.5.

1.4 Organization of the Thesis

Section 2 reviews previous research and modelling that is related to the present study.

Section 3 outlines the methodology and the selection of parameters, aggregation level and control areas consistent with the research objective.

Section 4 describes the information base which was available for this study.

Section 5 discusses the data management techniques utilized to prepare individual statistical summaries in the information extraction phase.

Section 6 presents the analysis techniques which were employed.

Section 7 discusses the trends which were identified in the analysis phase.

Section 8 presents the conclusions arising from this research and outlines further research needs.

2.0 LITERATURE REVIEW

This thesis deals with the extraction, analysis and presentation of census information. In Edmonton, the civic census is an annual undertaking which is used by various city departments. Home-to-work movements are monitored by origin-destination surveys which have been conducted in five-year intervals since 1961.

A major Federal Census is also held every ten years (1961, 1971, 1981 etc.) in Canada, with minor samples taken at five year intervals. The federal census serves to check demographic patterns and provides information about socio-economic patterns. It has recently become possible to assign co-ordinate values to street addresses and aggregate statistics into various zonal systems. This geo-coding process, which will be discussed further in subsequent chapters, enables comparisons and correlations to be made between data sources.

There have been a number of research projects and studies that have used Edmonton census data as part of their information base and have addressed public transit issues. This chapter will serve to review these studies and other literature associated with the cartographic presentation of data.

2.1 The Metropolitan Edmonton Transportation Study

In 1963, the Metropolitan Edmonton Transportation Study

(METS)$^{(1)}$ was conducted by the Edmonton District Planning Commission in co-operation with the Alberta Government. The study, which was concerned with the definition of travel characteristics in Edmonton, used 1961 civic census data complete with origin-destination information. This study introduced the METS zone system which was widely used in subsequent works. For convenience, the zonal boundaries were selected to conform with 1961 enumeration areas. Relationships between mode split and variables such as district income, district cars per dwelling unit and district time differential were identified. These "transit-determinant-relationships" were arrived at by regression analysis, the results of which are shown in Figure 2.1. District statistics refer to the aggregation of METS zone polygons into larger areal units. The study found that of all factors affecting transit use in 1961, comparative travel time was the most significant, followed by automobile availability.

The METS study recognized in 1961 that if public transit were to be considered as a viable alternative to automobile trips in the future, initial steps should be taken to improve the working environment of central-destined trips. The extent of transit usage in the future was considered to be strongly linked to the level of service which public transit had to offer.

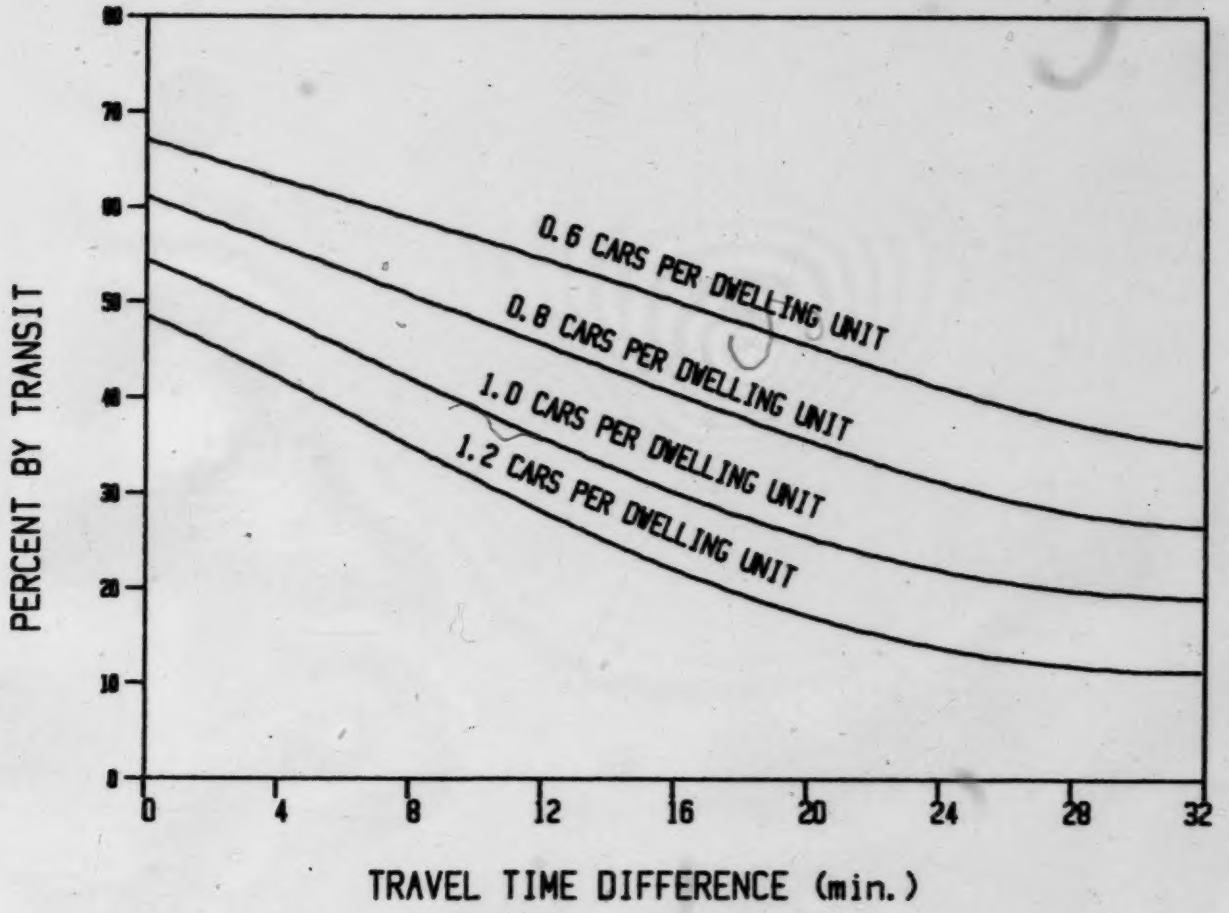

Figure 2.1 1961 Modal Split Relationships
Source: Metropolitan Edmonton Transportation Study, June, 1963[1]

2.2 An Investigation into the Modal Split Relationships in the City of Edmonton

In a thesis presented by Rhyason (M.Sc. Thesis, 1967)(2) census and origin-destination data from 1961 and 1964 were used to investigate transit travel characteristics in Edmonton.

The major portion of the 1961 information was collected in conjunction with the 1961 civic census and recorded in book form. A ten percent sample was extracted from the books for the METS study and then used in Rhyason's study, and twenty-five percent of the transit users were given separate interviews.

The 1964 origin-destination survey was collected on IBM mark-sense cards which were coded and transferred to computer as a 97 percent sample. Rhyason made use of economic status and travel time information to establish modal split relationships using 1961 and 1964 information as a base. These relationships were presented in the form of curve families of mode split versus travel time ratio, stratified by an income indicator. Rhyason's conclusions have been well-documented and are rewritten here because of their relevance to this study:

(i) "The radical changes in transit routes did not affect the modal split relationships even though they did result in an increased modal split by reducing travel time. Thus the effect of transit changes can be measured using the mode split relationships."

(ii) "Economic status and relative travel times are the chief factors affecting the choice of mode in Edmonton."

(iii) "The modal split relationships in Edmonton are dependent on the area of employment within the C.B.D."

(iv) "Parking plays an important role in mode split."

(v) "House sale value, which is easily obtained in Edmonton, can be used as a reliable measure of economic status."

(vi) "Relative travel time can be measured with equal reliability by both travel time difference and travel time ratio."

2.3 Density of Bus Routes in North Edmonton

Gill (M.Sc. Thesis, 1969)(3) chose to examine relationships between mode split and travel time factors. Other factors affecting choice of mode such as walking distance to bus stops and excess time factors were examined and used to suggest future route locations.

The traffic zone system used for Gill's analysis was a METS zone system slightly modified to compensate for expanding land use development. Data used for this study was acquired primarily through field surveys, and 1967 origin-destination information was used to compute mode split. The study is relevant to the current research in that mode split relationships were investigated for origin-destination subsets only. A specific study area was selected and only morning peak period trips to the central business district were used in the analysis. Gill also used regression analysis to determine mode split relationships. One of his planning recommendations was that "every effort should be made to reduce total travel time."

2.4 The 1971 Origin-Destination Study

In July 1974, the Studies and Research Section of the City of Edmonton Transportation Planning Branch released a summary of origin-destination information which was collected in conjunction with the 1971 civic census. The 1971 Origin-Destination Study(4) was based on 130,000 questionnaires completed by home interview. Data was processed by an optical card reader and although some difficulties were encountered during the information transfer process, sufficient check procedures and iterations were performed so as to consider the data set as a 100 percent sample. The 1971 origin-destination survey represented the most detailed inventory of transportation-related statistics ever assembled in Edmonton. For the first time in Edmonton, the process of geocoding was used to associate a co-ordinate value with a street address. Edmonton has utilized many different zonal systems in recent years and zonal boundaries have changed, primarily to compensate for changing land use patterns. This dynamic state hampers the analysis of trends based on aggregated statistics. One of the great benefits of the geocoding process is that statistics can be easily aggregated into any spatially-defined zonal system. This allowed for the simple aggregation of statistics into any desired zone system.

The study presented statistics in three geographical sub-area systems namely, traffic zones, traffic districts and P.L.U.S. areas. It was recognized that M.E.T.S. zone aggregations would also be required for comparison purposes; however, in 1971 traffic zones were established by the City of Edmonton Engineering and Transportation Department. Traffic districts describe an upwards aggregation of traffic zones. To allow for simpler aggregation, traffic zone numbers are coded in a manner which links its association with its district. P.L.U.S. areas were established by the City of Edmonton Planning Department in 1971.

The tabulations contained within the study report provide 1971 information on:

(i) General characteristics such as population, employees, employment, number of dwellings, persons per dwelling, cars per dwelling and bedrooms per dwelling.

(ii) Under 18 years of age population breakdown.

(iii) Over 18 years of age population breakdown.

(iv) Work trip departures.

(v) Work trip arrivals.

(vi) Areas of the geographic sub-areas (polygons)

These tabulations represent the only known aggregated source of 1971 demographic information. Attempts to locate the original magnetic tape files were not successful.

2.5 Work Trip Generation Models

In 1977, Clement$^{(5)}$ presented a thesis entitled "Work Trip Generation Models", which was concerned with the development of work trip generation models. These models would enable transportation planners to forecast the trip generation phase of the traditional four-step transportation model. Clement restricted his work to the analysis of peak hour work trips which included trips made by post-secondary students. The justification for this restriction is based on the City of Edmonton Transportation Planning Branch estimate that 85% of morning peak hour trips by all modes are work trips.

Clement identified four types of trip makers:

(i) *"those who have a choice of travelling by automobile or by transit"*

(ii) *"those who are captive to the transit mode"*

(iii) *"those who are captive to the auto-driver mode"*

(iv) *"those who are captive to the auto-passenger mode"*.

For the purpose of trip generation modelling, Clement distinguished between choice and captive transit riders and considered auto-passengers as temporarily-indulged transit riders. Walk trips were not used in the inter-zonal modelling process, since it was assumed that walk trips were destination-oriented. Previous studies$^{(2)}$ have shown that mode splits for C.B.D. destination zones are typically 3% higher when walking and other trips are excluded.

The 1971 census and origin-destination survey mentioned in the previous section formed the information base for Clement's research. This data was extensively used for the calibration of his trip generation models. To make the reader aware of the spatial distribution of transportation-related statistics, he presented data on a geographic base using self-developed computer-mapping software. These thematic maps were based on the traffic zone level of aggregation and utilized polygon co-ordinate files from the census geocoding process. Previous census information was not available in a geocoded form; therefore Clement could not use computer-aided thematic mapping to analyze trends in transportation-related statistics. It became apparent to the author that for subsequent census years in which the geocoding process was used, the swiftly-produced graphics could constitute an effective analysis tool for this purpose.

2.6 Cartographic Presentation

Jacques Bertin$^{(6)}$, in a paper entitled "Cartography in the Computer Age" discussed the importance of graphic representation.

"A properly conducted research study includes an

experimental stage in the course of which the manipulation of data brings out the internal relations of the subject matter. During this stage the research worker can use both mathematics and graphical methods ... a collection of properly constructed maps is an experimental tool with which to discover groupings, classifications correlation and to define regions."

Bertin recognized the ability of the human eye to communicate spatial variation in an "instant of perception". He listed important observations of reader behaviour, two of which are restated here:

(i) "The observer is able to base his reflections on the totality of the data which has been surveyed."

(ii) "The observer is able to make groupings at all levels".

The ability of the human eye and brain to visually process information has been well documented. One of the problems facing graphic information processing in the past was the labor-intensive task of preparing comparative maps. The computer has remedied this situation by making it possible to produce high-quality images swiftly using minimal resources, thereby allowing the researcher more freedom to perform graphical analysis.

Bertin,(7) in a paper entitled "Visual Perception and Cartographic Transcription", envisioned rapidly produced "detailed, comprehensive monochrome maps which systematically explore the range of values covered by specific parameters ...". He identified three main map functions;

(i) information storage
(ii) information processing
(iii) communication.

This research will rely primarily on the last two map functions to help investigate trends in travel characteristics in Edmonton. Bertin's focus is primarily on the problems and theory associated with thematic cartography. Most of the above-mentioned theory can be applied to graphics of any kind, including simple x-y plots and bar charts. For the application of thematic cartography to be useful, a full understanding of error and map accuracy is required. Thematic (choroplethic) maps all display a generalization of the real world and as such, can introduce bias and error into the communicative process. An excellent reference on the problems associated with thematic mapping is presented in a paper entitled "Error on Choroplethic Maps: Definition, Measurement, Reduction" by George F. Jenks and Fred C. Caspall.(8)

3.0 METHODOLOGY

This section will outline the methods and approach used to determine trends in transit travel characteristics. The chosen level of aggregation will be introduced and discussed. The research guidelines will be restated and the measures of effectiveness required to assess L.R.T. impact will be listed.

3.1 The Selection of the Time Segment

Geocoded census data, complete with origin-destination information was available for the census years 1971, 1976 and 1981. Edmonton's light rail transit line was inaugurated on April 22, 1978; therefore, the comparison of 1976 and 1981 data would adequately reflect pre-L.R.T. and post-L.R.T. conditions. The inclusion of 1971 data would help to identify trends over a ten-year period. If this period also represented a state of constant economic growth, the selection criteria mentioned in Section 1.0 would be satisfied.

Figure 3.1, Figure 3.2 and Figure 3.3 illustrate summaries of Alberta unemployment rates and Edmonton building permit values in recent years. The figures illustrate a growth period which was followed by a dramatic decline in 1982. The period for which data was available was also seen to display economic stability. The time segment 1971-1978 was therefore found suitable for the

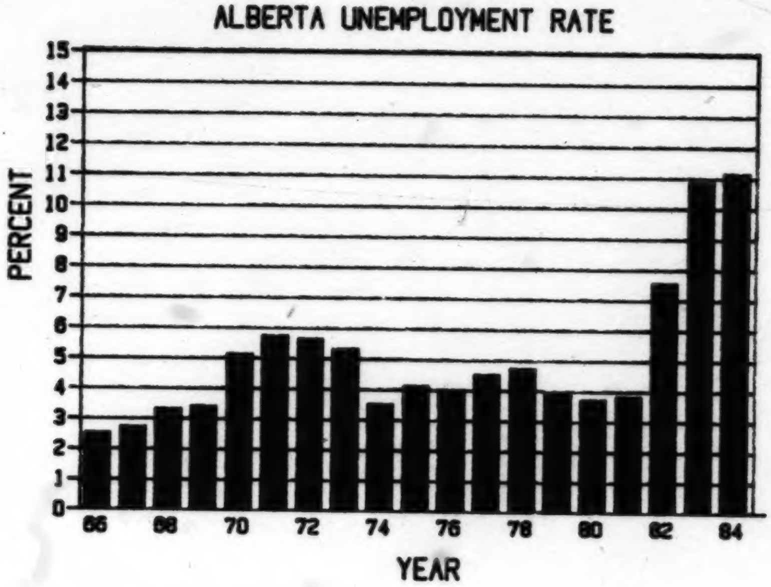

Figure 3.1 Alberta Unemployment Rate (1966-1984)
Source: Statistics Canada Catalogue No. 71-201
Note: 1984 annual statistic is based on monthly statistics from January-June, 1984

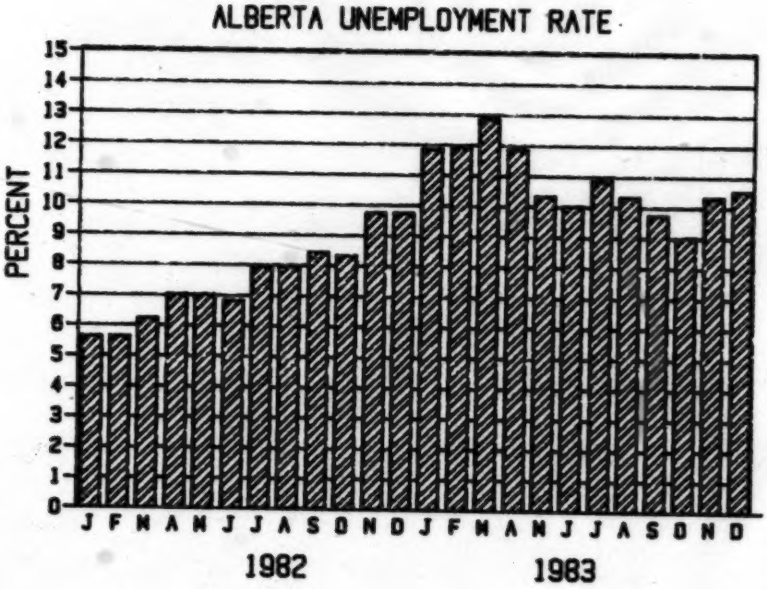

Figure 3.2 Alberta Unemployment Rate (1982-1983)
Source: Statistics Canada Catalogue No. 71-001

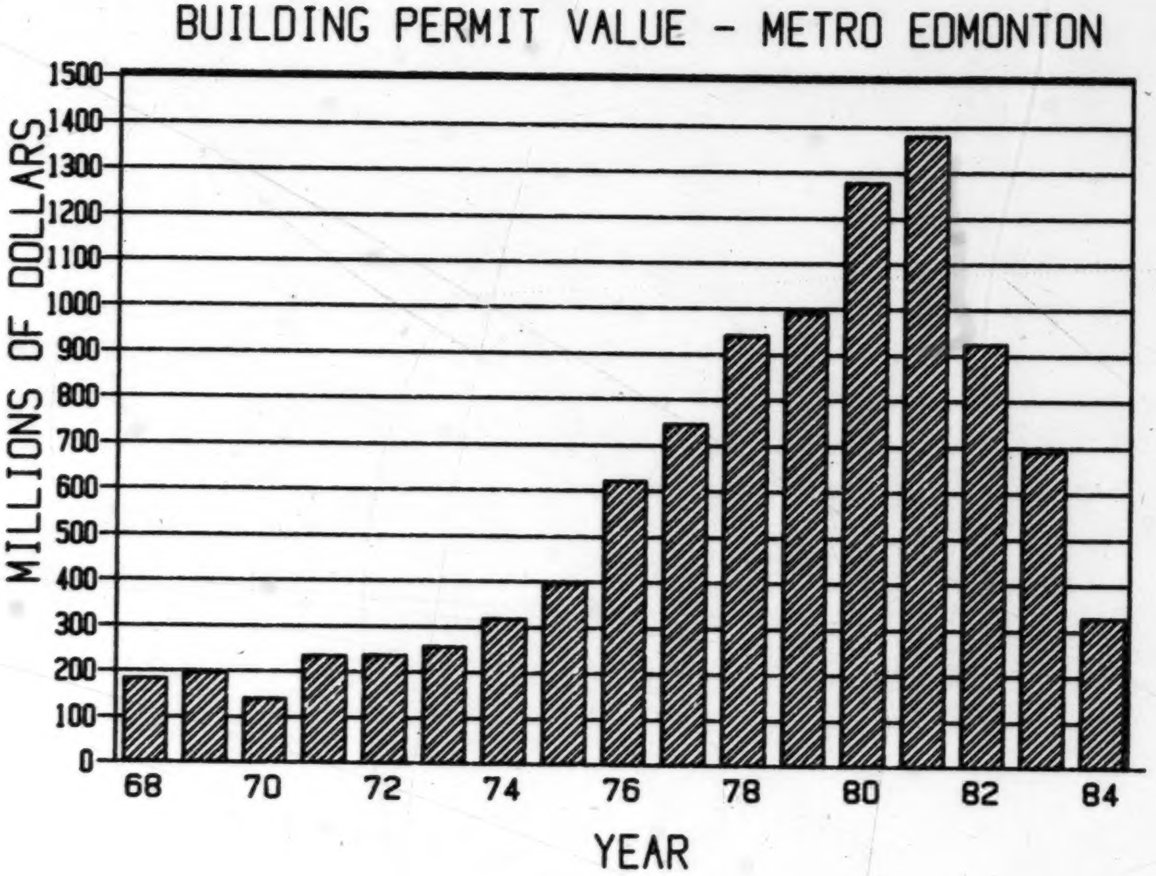

Figure 3.3 Building Permit Values for Metro Edmonton (1968-1984)

Source: Statistics Canada Catalogue No. 64-001 Monthly and 64-203 Annual

Note: 1984 statistic is an annual estimate based on monthly statistics for Jan.-Apr. 1984 evaluation of trends in transit travel characteristics.

3.2 Geocoding

Geocoding was described in Section 2.4 as a process by which households coded by street address are converted into a geographic location. It is a system by which basic household units are referenced to a common geographic datum. This land-related system was introduced in Canada by Statistics Canada in 1971. A one-to-one correspondence exists between a street address (hence statistic sample) and an X-Y co-ordinate which, in Edmonton, is based on a six degree Universal Transverse Mercator grid. Zonal systems of any type are then created by specifying co-ordinate strings which make up a polygon network. The process of aggregation is achieved by matching an X-Y co-ordinate with its particular zonal polygon.

In Edmonton, this process has been carried out for the federal and civic census years 1971, 1976 and 1981 and aggregation has been achieved for a number of zonal systems.

3.3 The Selection of the Aggregation Level

In recent years, the City of Edmonton has used two main zonal configurations to assist in the analysis of transportation-related statistics.

The Metropolitan Edmonton Transportation Study(1), (METS), used a zonal configuration as shown in Figure 3.4.

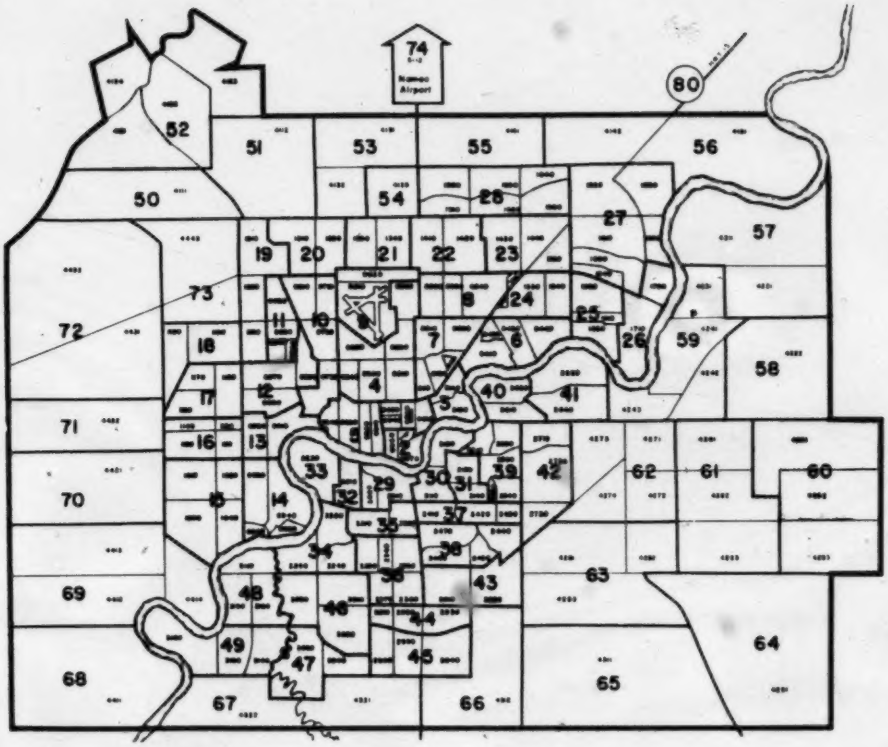
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Figure 3.4 M.E.T.S. Zones
Source: Metropolitan Edmonton Transportation Study, June, 1963(1)
(Not protected by Copyright)

The METS zones were also used in the 1964 origin-destination survey and in Dale Brian Rhyasons' M.Sc. Thesis.(2)

In 1971 the City of Edmonton Engineering and Transportation Department introduced a Traffic Zone System, as shown in Figure 3.5. This zonal system, which might be better classified as a transportation zone system, has been used in every major origin-destination study since 1971, with only slight modifications. Figure 3.6 illustrates the traffic zones associated with the 1981 civic census.

The traffic zone system has been used in this analysis because of its predominance in the time segment involved in this study. This zonal system displays a neighborhood level of aggregation, small enough to display neighborhood trends. The disadvantages of using this system is that sample sizes can sometimes be too small to be statistically significant.

3.4 Preliminary Analysis and Selection of Control Areas

In order to assess the impact of light rail transit on transit travel characteristics a region north of the North Saskatchewan River and east of 97 Street was chosen as a study area. The northeast light rail transit line diagonally bisects this quadrant of the City of Edmonton. The objective of the preliminary analysis was to examine a variety of transportation-related parameters and to select a control area which would exhibit similarity and stability when compared to the northeast study area. Comparisons

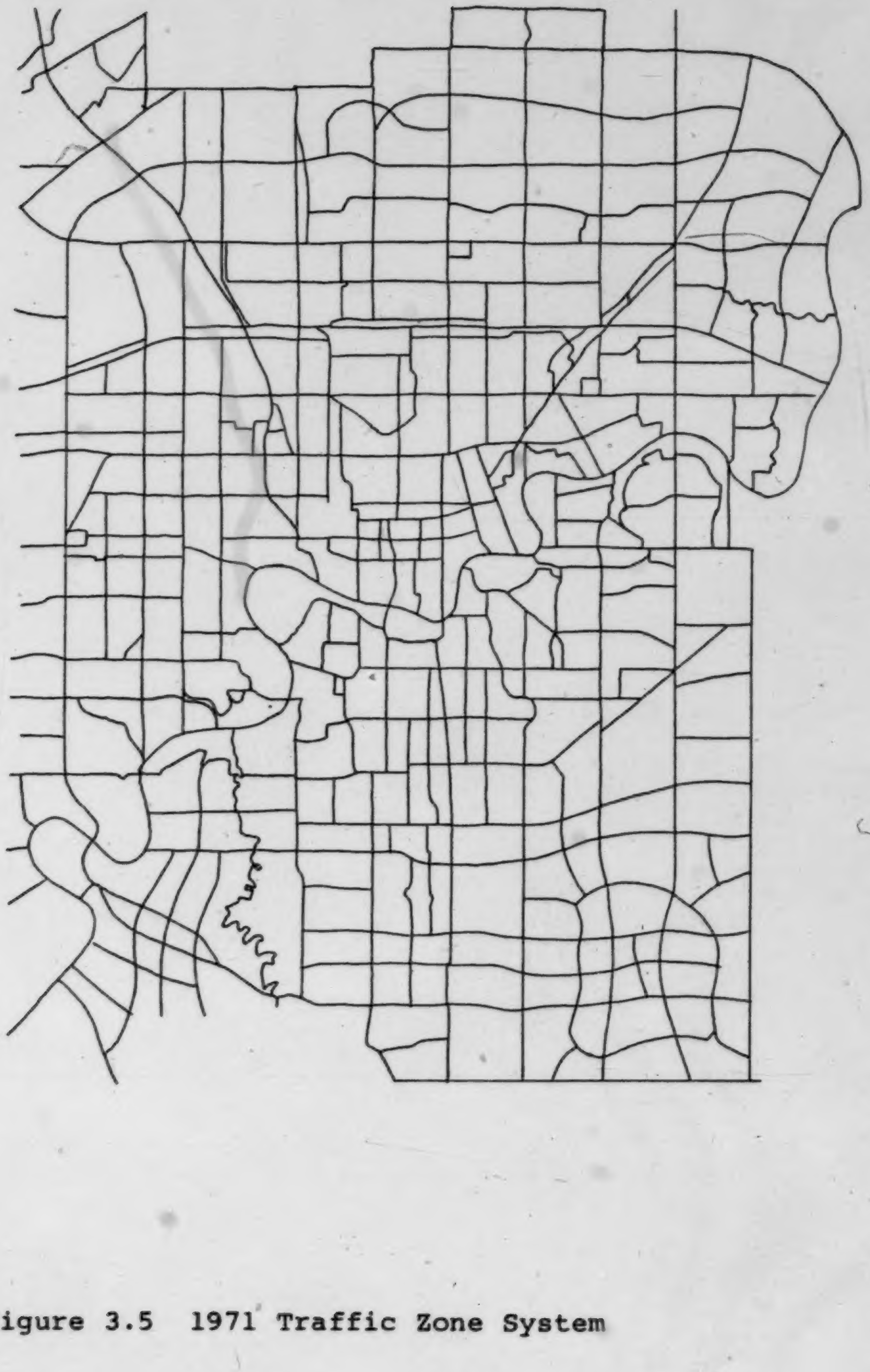

Figure 3.5 1971 Traffic Zone System

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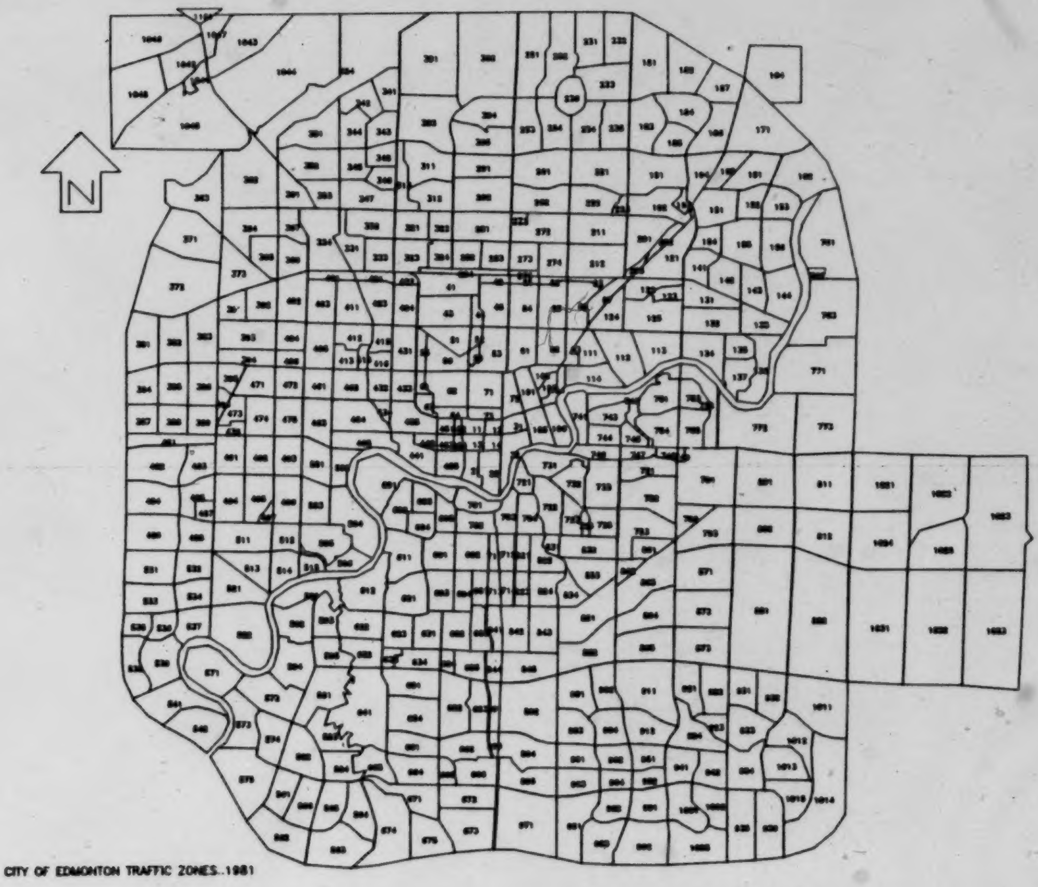

N
CITY OF EDMONTON TRAFFIC ZONES..1981

Figure 3.6 Zonal System Used in Conjunction with the 1981 Civic Census

between the study area and the control area could then reveal differences in travel characteristics between regions which are under the influence of L.R.T. and regions that are not. Such a comparison would be made under the same general economic conditions and would only be subject to the variability that exists between Edmonton communities.

Parameters used for the selection of the control area included population trends, population density figures and socio-economic status. Consideration was also given to barriers found within the city, such as railways, industrial areas and the North Saskatchewan River. Other barriers to traffic movement include roadway capacity constraints and regions with high socio-economic status.

The preliminary analysis revealed two control area alternatives:

(i) a western area including the Mayfield, Britannia, Jasper Place, Westmount, Dovercourt, Primrose and Callingwood communities;

(ii) a south-east area including the Bonnie Doon, Ottewell, Parkallen, Belgravia and Millbourne communities.

Similarities with the N.E. study area were present in both alternatives. The western control area was selected for the following reasons:

(i) The western area is similar to the study area in that a river crossing is not required to reach the C.B.D.

(ii) The western area is similar to the study area in that a river crossing is required to reach the university/health sciences area.

(iii) The western area will serve as better control area for future planning purposes in that it will remain virtually unaffected by a proposed southern L.R.T. extension.

(iv) It was felt that growth in the Primrose area closely approximates growth in the study area.

The data collection phase of this research has also included statistics from a region south of the North Saskatchewan River and west of 104 Street, since future L.R.T. development is proposed for this area. The study area, the western control area and the southwestern future study area are shown in Figure 3.7.

3.5 Parameters

The objective of this research, stated in Section 1.2, was "to study trends in transit travel characteristics and, in particular, assess the impact of the implementation of light rail transit in Edmonton". The information required to assess these trends falls into four general categories:

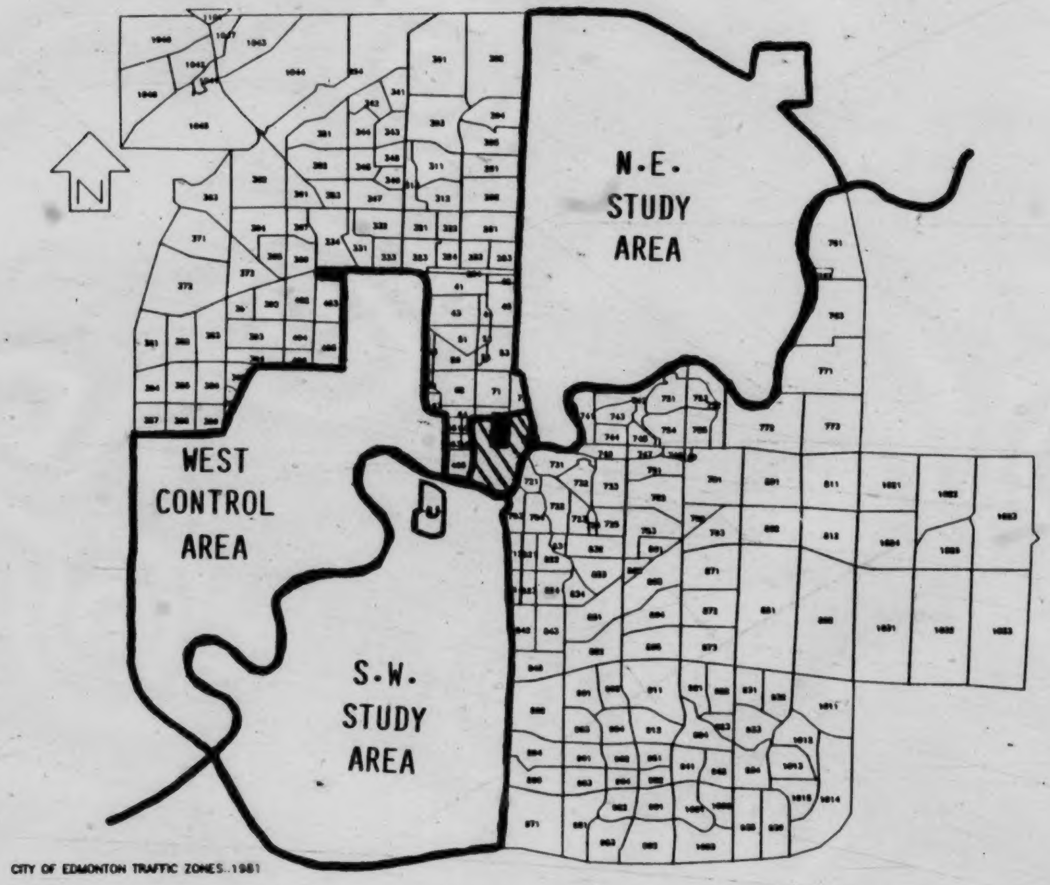
(i) demographic data

(ii) trip-related information

(iii) transportation system information

(iv) geographical information.

Demographic parameters aggregated on a traffic zone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N.E.
STUDY
AREA
WEST
CONTROL
AREA
S.W.
STUDY
AREA
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CITY OF EDMONTON TRAFFIC ZONES 1981

Destination Zone Legend

■ C.B.D.

▨ Central

U University/Health Sciences

Figure 3.7 Study Areas and Selected Destination Areas

level include:

(i) population
(ii) employees
(iii) households
(iv) average household income.

Trip information parameters, also aggregated on a traffic zone level include:

(i) morning peak period work trips to the central business district
(ii) morning peak period work trips to the central area
(iii) morning peak period work trips to the university area
(iv) mode split to the above-mentioned destination areas.

Transportation system information is limited in this study to:

(i) a measure of transit availability, namely, the number of transit stops per zone,
(ii) scheduled transit travel time.

Geographical information includes zonal areas from which density statistics can be determined. The source of this information will be discussed in detail in Section 4.

4.0 INFORMATION BASE

The statistics used for this analysis were available through three sources:

(i) Civic census records
(ii) Federal census records
(iii) City of Edmonton Transportation Departments.

This section will describe each one of the data sources in detail.

4.1 Civic Census Records

In Section 2.0 it was mentioned that in Edmonton, a civic census is performed once a year and that, at five-year intervals, origin-destination information is collected. The origin-destination survey forms the prime data source for transportation-related research.

This study has used demographic and origin-destination information from 1971, 1976 and 1981 civic census records. The 1981 census questionnaire represents the most in-depth summary of transportation-related information ever asembled in Edmonton. The questions pertain to the status of the dwelling, occupants and the work travel habits of the occupants. Specifically, the following information is available:

- household address
- ownership status
- vacancy status

- dwelling type
- number of cars in the household
- number of persons in the household

For each occupant, the following statistics are available:

- year of birth
- school tax support
- marital status
- occupation status
- length of residence
- work destination address
- mode of travel
- work start time
- work end time

The geocoding process has been performed on the 1981 census data so that household addresses are referenced by traffic zone number, traffic district number and M.E.T.S. zone number. An X-Y co-ordinate for each household is also available.

The 1981 occupation status is coded for eleven categories:

0 = pre-schooler
1 = kindergarten to grade 6
2 = grade 7 to 9 (Junior High)
3 = grade 10 to 12 (Senior High)
4 = post secondary
5 = homemaker

6 = employed full-time
7 = employed part-time
8 = unemployed
9 = retired
10 = other

The mode of travel section of the 1981 origin-destination survey included seven coded responses:

1 = car driver
2 = car passenger
3 = transit and/or light rail transit
4 = park and ride
5 = walk
6 = other
7 = invalid code or blank.

Pre-1981 census questionnaires categorized occupation status as either employed, housewife, student, retired or unemployed. Mode choices were restricted to auto-driver, auto-passenger, transit, walk and other modes. The advent of light rail transit in 1978 prompted the inclusion of the "transit and/or light rail transit" category in 1981. In order to accurately assess trends in transit travel characteristics, it is imperative that there be uniformity in census questionnaires over the chosen time segment. In 1981, transit and light rail transit have been brought together into one category as code 3. From a management perspective, this enables one to separate the total transit component from the other available modes. This is also consistent with the integrated operational aspects of the bus-feeder system which is applied in Edmonton. To fully understand the choices available to the public transit user, it is felt that other categories are required. The possible choices could be:

0 = invalid code or blank
1 = auto-driver
2 = auto-passenger
3 = bus transit
4 = light rail transit (walk-on)
5 = bus transit plus light rail transit
6 = park and ride bus transit
7 = park and ride light rail transit
8 = auto-passenger plus bus transit
9 = auto passenger plus light rail transit
10 = walk
11 = other (bicycle, motorcycle, etc.)

This choice pattern requires a two-byte field but it allows a more detailed analysis of mode choice. A comparison with 1981 data could be made by simply aggregating responses.

It has been suggested that 1976 census information contains some omissions and coding errors. Problems occurred during the transfer of questionnaire information to magnetic tape, resulting in a loss of information. Exact documentation of the extent of the problem is not available; however, it is known that there were approximately 6200 undecipherable addresses associated with the 1976 origin-destination survey.

4.2 Federal Census Records

Once every ten years Statistics Canada collects a 100% sample of information concerning age, sex, marital status, mother tongue, number of occupants per dwelling and type of dwelling. In the 1981 Census of Canada a 20% sample of the population was asked for more detailed information concerning religion, education, income and other social and economic characteristics.

Of particular importance to this study was the averge annual household income of study area residents. This statistic would act as a socio-economic indicator and provide a basis for comparison between traffic zones. Average annual private household income for 1980, based on a 20% sample for census tracts, was extracted from Statistics Canada's report 95-949, volume 3, profile series "B" on selected social and economic characteristics for Edmonton.

4.3 Information Provided by the City of Edmonton

4.3.1 Origin-Destination Data

Work trip information collected in the origin-destination portion of the 1971, 1976 and 1981 civic census questionnaires has been processed and converted into "trip tables". These data files are organized by time and mode and represent the internal movement of Edmonton residents.

4.3.2 Bus Stop Locations

Edmonton Transit keeps on file a record of bus stop locations within their jurisdiction. As an indicator of transit availability, it was decided to determine the bus stop density within traffic zone areas. The 1983 bus stop index locations were plotted on a large scale city map and traffic zone boundaries were superimposed, yielding the required density statistic.

4.3.3 Scheduled Transit Travel Time

In order to facilitate the analysis of transit travel characteristics, zonal transit travel times based on 1976 and 1981 Edmonton Transit schedules were added to the information base. Different route alternatives were examined and total travel time on transit including transfers was recorded. Walk and wait times were not included in this statistic. 1981 information sources included an Edmonton Transit route guide for winter 1980 and a set of route schedules for fall, 1979. This information is intended to reflect conditions existing during the 1981 census-taking period.

1976 information sources included a 1977 Edmonton Transit route guide and route schedules for April 1976, September 1976 and April 1977. Light rail transit was not operational at this point in time.

Sample points used in the extraction process consisted of major intersections and transfer points. Routes used in the determination of travel times were, in the opinion of the author, alternatives which would appeal to a majority of transit patrons. Factors considered in selecting route alternatives included number of transfers and directness of path. Travel times are based on A.M. peak period trips which utilize direct express routes whenever possible. When a considerable walking distance such as 500 meters or greater separated the patron from a direct express route, it was assumed that "front door" collector service would be used. Travel time contours were then sketched using the extracted values as a base for direct interpolation methods. A traffic zone system base map was then superimposed to determine the approximate scheduled transit travel time for traffic zone centroids. Appendix A contains reproductions of the travel time contour sketches.

4.3.4 Zonal Areas

The geocoding process mentioned earlier aggregates statistics into a framework of areal units. The aggregation level chosen for this study is based on the traffic zone system as described by a polygon file of X-Y co-ordinates. Zonal areas were computed from this file and included in the information base so that density statistics could be determined.

5.0 DATA MANAGEMENT

The data and information contained in the preceding chapter had to be assembled in a manageable form for analysis. Tabular information had to be coded and extraction software was written to transfer census information into condensed data files. The University of Alberta computing facilities were used for data management functions. For each of the three census years under investigation, demographic and trip information was collected and stored on file. Parameters such as population, households and employees per traffic zone were either coded from printed summaries or extracted from larger data sets. An index of files and documentation of extraction programs is included in Appendix B.

5.1 1971 Reference Parameters

1971 reference parameters were obtained from the previously-mentioned summary entitled "The 1971 Origin-Destination Study" which was produced by The City of Edmonton Transportation Planning Branch in July, 1974.(4) Population, household and employee statistics were coded for traffic zones within the three study areas. The 1971 census information represents a survey sample of close to 100 percent and formed the data base for T. Clements' research in 1976.

5.2 1976 Census Record Extraction

Computer programs were developed to extract demographic information from 1976 census records. The 1976 data file CEN.76.CONV.MZ.02 (which is a concatenation for 1976 census information geocoded for M.E.T.S. zones, version two) was supplied on magnetic tape and is filed at the University of Alberta magnetic tape library as volume L128L0, rack number 007407. The data file consisted of 166,620 records, each representing a civic household and coded into the following zonal systems:

(i) census tract number
(ii) enumeration area
(iii) traffic zone origin
(iv) M.E.T.S. zone origin
(v) M.E.T.S. district origin
(vi) destination traffic zone
(vii) destination M.E.T.S. zone
(viii) destination M.E.T.S. district.

The record layout of file CEN.76.CONV.MZ.02 is contained in Working Paper No. 2 in the Transportation Engineering Library, Department of Civil Engineering, University of Alberta.

A Fortran program called "EXTRACT" was developed to extract population, household and employee statistics and classify each record into one of three output files corresponding to the three study areas. Each output file then contained a reduced data set containing selected parameters for study area households and was then sorted on the basis of ascending traffic zone number. The public utility program *SORT was used for this purpose.

Another fortran program called "ACCUM" was developed to aggregate traffic zone statistics. Occupation codes 1 (employed) and 3 (student) were used to accumulate employee statistics under the assumption that the 1976 "student" classification includes post-secondary students. Post-secondary students have been included in past work trip analyses as employees. Output from program "ACCUM" was printed and stored on magnetic tape for subsequent use.

5.3 1981 Census Record Extraction

In July 1983 the data file CENSUS.81.CONV.V2 (which is a concatenation for 1981 census information geocoded, version 2) was supplied on a magnetic tape filed at the University of Alberta magnetic tape library as volume L129L0, rack number 007432. This data file consisted of 213,665 records and was coded according to census tracts, sub-census tracts, enumeration areas and traffic zones.

The record layout of file CENSUS.81.CONV.V2 is contained in Working Paper No. 3 in the Transportation Engineering Library. This data file differs from the 1976 data file in many ways. The data types include character information as well as half and full-word binary. Each record in the 1981 file does not necessarily constitute information for one household. A "continuation flag" identifies whether or not one record per household is used. The record structure for the 1981 file is significantly different from the record structure used in the 1976 file. The file CEN.76.CONV.MZ.02 used a fixed length blocked structure whereby each record was of a fixed length and short records were padded with zeros. The 1981 file utilizes a variable length blocked record structure which is prefaced by a 4-byte descriptor which describes the length of each record. Variable-length records usually require more processing time since descriptors must be uncoded for each record read.

The 1976 version of program EXTRACT was modified to accept the 1981 datafile. Pertinent statistics were extracted and households were classified into output files representing each of the three study areas. Each of the three files were sorted and aggregated into traffic zones using a modified version of program "ACCUM". Occupation codes used for the 1981 census aggregation included code 4 (post secondary), code 6 (employed full-time) and code 7 (employed part-time).

5.4 1971 Trip Tables

A review of the information contained on City of Edmonton Transportation Mangagement Department magnetic tapes uncovered a series of trip tables from the census year 1971. These tables are based on the traffic zone level of aggregation and correspond to a zonal system which is consistent with the afore-mentioned "1971 Origin-Destination Study".(4)

The tables are stored at the University of Alberta magnetic tape library on rack 002832, volume GT2832. This tape contains twenty-four trip tables classified by mode and time period. The last six data sets classify work trips according to "captive" or "choice" alternatives. The trip information used in this study consisted of the peak period data sets:

(i) PEAK.AUTO.NUMBERS
(ii) PEAK.PASS.NUMBERS
(iii) PEAK.BUS.NUMBERS
(iv) PEAK.WALK.NUMBERS

A detailed analysis of the record structure revealed that the trip tables are in the form of a 313 x 320 array:

T_{ij} where i = destination zone
and j = origin zone.

The array is stored as 16 records each containing 6260 integer half-words. The data structure of this tape is consistent with the manner in which higher-dimensional arrays are stored in memory.

> "Storage is arranged as if the first subscript were varied most rapidly and the last subscript varied least rapidly."(9)

The record structure of the 1971 trip tables was verified by examining the input requirements for an old computer program called "TABEXTAGG" which was filed on tape library rack 001881, volume GT1881. This extraction program was designed to read the above-mentioned trip tables and led to the discovery of a zone vector file on the same tape.

Extraction program "TT71TRAF" was developed to read the trip table, select study area traffic zone origins and aggregate arrivals into the following destination zones:

(i) Zones within the central area (0011-0032), both as a group and on an individual basis
(ii) Zones designated as the central business district (0012 and 0014)
(iii) University zones 603 and 604, both as a group and on an individual basis.

The printed tables contained in Working Paper No. 6 on file in the Transportation Engineering Library, Department of Civil Engineering, University of Alberta, summarize information extracted from the 1971 trip tables. Tabular values correspond to trips made from selected origins to selected destination zones and are ordered as follows for each of the three study areas:

(i) auto-driver trips
(ii) auto-passenger trips
(iii) transit trips
(iv) other trips
(v) % auto-drivers
(vi) % auto-passengers
(v) % transit
(vi) % others

5.5 1976 Trip Tables

1976 trip tables were supplied by the Transportation Management Department of the City of Edmonton. The zonal system used to describe this origin-destination information is consistent with the 1979 Traffic Zone Plan.

The tables are comprised of four distinct peak period data sets, listed as follows:

(i) AUTODR.76.ZO
(ii) AUTOPA.76.ZO
(iii) TRANPA.76.ZO
(iv) OTHERS.76.ZO

Each trip table is in the form of a 372x371 matrix. The first record of each file contains a full-word zone vector which lists contributing zones. Each subsequent record consists of 371 full-word integers which represent arrivals at each of the 371 destination zones from a specific origin zone.

As for the 1971 data, an extraction program was developed to select study area traffic zone origins, aggregate arrivals to major destination areas and compute modal percentages. Printed summary tables are contained in Working Paper No. 5 on file in the Transportation Engineering Library, Department of Civil Engineering, University of Alberta.

5.6 1981 Trip Tables

In January 1984 the Transportation Management

Department of the City of Edmonton supplied a condensed version of the 1981 origin-destination trip matrix. This matrix was originally extracted by using the U.T.P.S. (Urban Transportation Planning System) software package. The condensed file contained A.M. peak period work trips from selected study area origins to downtown and university destinations and was supplied in auto-driver, auto-passenger and transit mode categories. The "walk" and "other" modes were not available in this table. The data was transformed into a format which was compatible with 1971 and 1976 data and modal percentages were computed. Printed summary tables are contained in Working Paper No. 8 on file in the Transportation Engineering Library, Department of Civil Engineering, University of Alberta.

5.7 Merging Statistics

Two condensed data files existed for each census year, one with demographic information and one with trip-related information. Trip information was further separated into two files, one with trip numbers and one with modal percentages. The common link between files was the traffic zone number and it was a simple matter to merge zonal statistics into a common file. The three files were then read sequentially and a single output file was generated. This single output file became the basis for the analysis of census year statistics. Zonal areas were coded directly into each yearly output file. A simple Fortran program then computed population and employee density statistics as well as transit trips per hundred households. A summary of all of the statistics was then output in a free format file.

To each yearly summary file, other zonal parameters were appended. These parameters included:

- (i) scheduled transit travel times to the C.B.D. and university
- (ii) average household income, 1980 (added to 1981 file only)
- (iii) bus stop density (1981)

The yearly summary files thus formed the basis for subsequent analysis. Analysis software can require varied forms of input format. The free-format summary files are easily read and transformed to meet these requirements.

5.8 Estimation of Modal Percentages

Modal percentages are computed from trip tables according to the ratio:

$$\frac{\text{total MODAL trips to a particular destination zone}}{\text{total number of trips by all modes to the same destination zone}}$$

In this analysis, mode split is an estimate of the proportion of transit work trips travelling to a specific destination in A.M. peak periods. As such it is the proportion of occurances among a sequence of "n" trials.

The variance associated with such a proportion decreases with higher sample sizes and may be approximated by the following relationship(10):

$$\text{Var}\ (p) \cong \frac{p\ (1 - p)}{n} \qquad (5.1)$$

where p = modal percentage

n = total trips by all modes

The traffic zone level of aggregation represents a system of small neighborhood zones which cover a large range of generated trips. A mode split estimate for a zone with low trip production is less significant than a mode split estimate for a zone with high trip production. In this analysis, the total number of trips is reduced to the set of work trips that are attracted to selected destination zone groups of the central business district, central area and university area. Generally speaking, fewer trips are made to the C.B.D. and university destinations than to the central area.

The variance associated with mode split for C.B.D. and university destinations is therefore typically higher than for central-destined trips. The standard deviation of the proportional mode split is typically around 5-7%. To avoid placing emphasis on mode split statistics which display a high variance, a tolerance of ±15% was imposed on the standard deviation of mode split statistics. All mode split statistics which, due to small sample size, display a standard deviation of ±15% or greater have been rejected from the sample.

6.0 DATA ANALYSIS

The availability of a complete and manageable information base allowed for the initiation of the analysis phase of this research. The research objective restated was:

> "to study trends in transit travel characteristics and, in particular, assess the impact of the implementation of light rail transit in Edmonton".

Three analysis techniques were used to satisfy this objective. They were:

(i) Regression analysis
(ii) Graphical analysis
(iii) Control area comparisons

6.1 Regression Analysis

Regression analysis was utilized to identify possible relationships between transit usage and the following independent variables:

- population density
- employee density
- average scheduled transit travel time
- average household income
- bus stop density

The dependent variables used to represent transit usage were

(i) mode split to the central area

(ii) mode split to the central business district

(iii) mode split to the university area.

The theory of regression analysis is well explained in a variety of statistical textbooks. The method employed in this analysis is to assume a linear relationship of the form

$$Y_e = a + bX$$

where Y_e = an estimate of the dependent variable

X = the magnitude of the independent variable

and "a" and "b" are the y-intercept and regression line slope, respectively.

The procedure used in this analysis was to fit a regression line to the observed values and determine the validity of the regression line by examining the following measures:

(i) r^2, the coefficient of determination

(ii) mean squared error

(iii) r, the correlation coefficient.

Software was available to quickly and efficiently perform the regression, compute the statistical measures and display the regression plot. The particular package used was the Interactive Statistical Graphics Package (ST. Package) offered by Computing Services at the University of Alberta, and originally written by Jane F. Gentleman and R.M. Dunn of the Department of Statistics at the University of Waterloo, Ontario.

Regression plots were produced for each mode split-destination area, year and study area, where applicable. Copies of the regression plots can be found in Appendix "B" of Working Paper No. 10 on file in the Transportation Engineering Library, Department of Civil Engineering at the University of Alberta.

No single independent variable was found to have a profound relationship with mode split. Of the independent variables tested, average household income and scheduled transit travel time to the central area showed the strongest interrelationship.

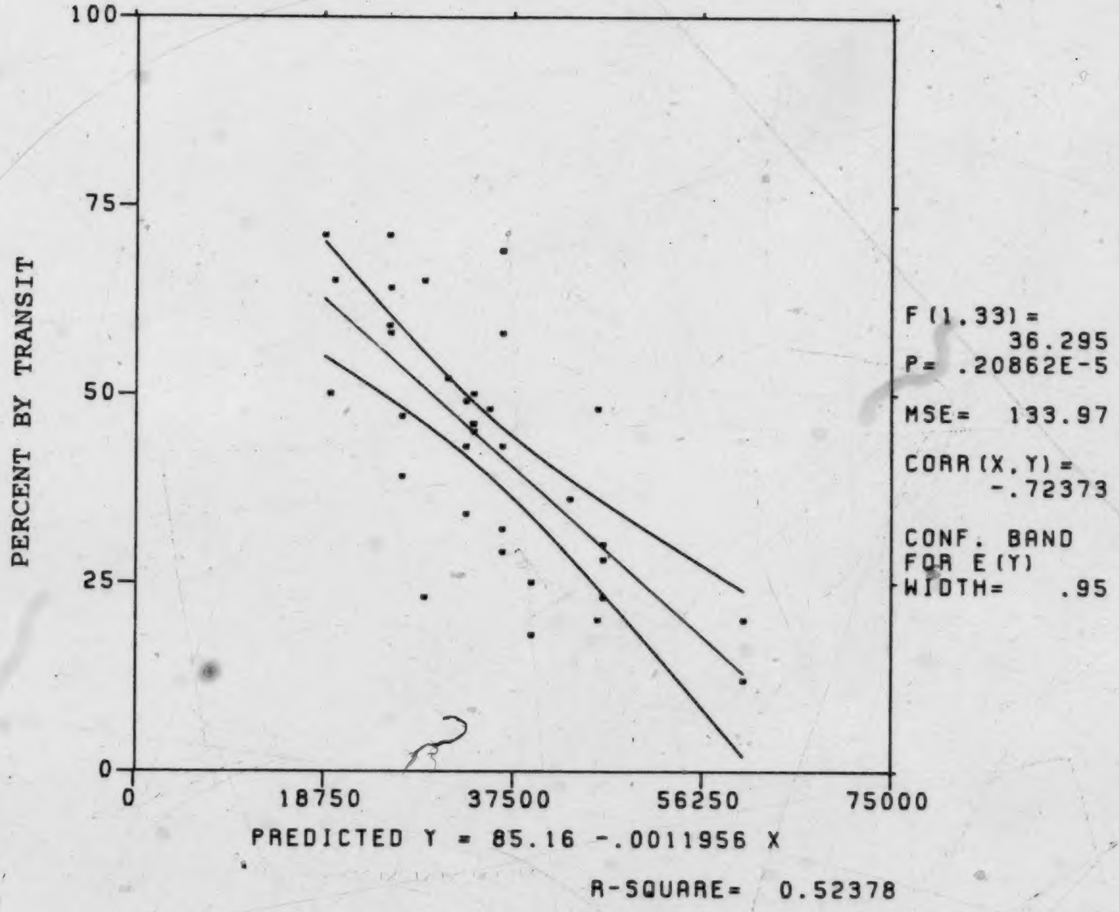
A negative correlation exists between mode split and average household income as shown in Figure 6.1 which shows the relationship for central-destined trips. A summary of mean squared errors, correlation coefficients and r-squared values follows:

TABLE 6.1

Mode Split Vs. Average Household Income, 1980

TO/FROM	MSE	CORR.	R-SQUARED
CBD/N.E.	301	-0.36	0.127
CBD/WEST	317	-0.49	0.245
CBD/S.W.	324	-0.52	0.272
CENTRAL/N.E.	61	-0.59	0.353
CENTRAL/WEST	188	-0.63	0.398
CENTRAL/S.W.	134	-0.72	0.524
UNIV./N.E.	158	-0.31	0.096
UNIV./WEST	331	-0.20	0.039
UNIV./S.W.	252	-0.17	0.028

A negative correlation also exists between mode split and scheduled transit travel time. Figure 6.2 illustrates



AVERAGE HOUSEHOLD INCOME, 1980 (dollars)

Figure 6.1 Regression Plot of Mode Split Vs. Average Household Income, Southwest Zones, 1980
Source: 1981 Census of Canada, Catalogue 95-949, Vol. 3, Series B

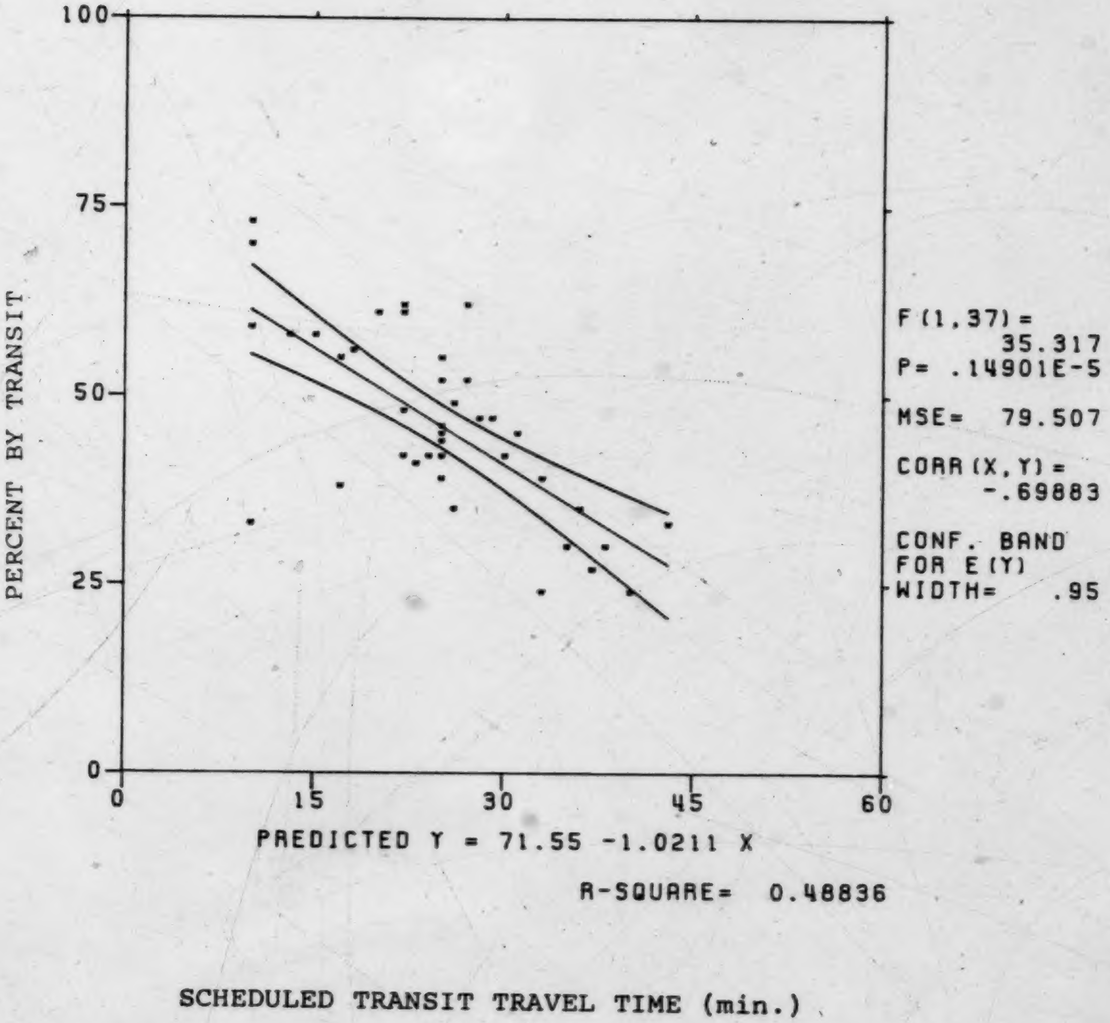


Figure 6.2 Regression Plot of Mode Split Vs. Scheduled Transit Travel Time to the Central Area, from Northeast Zones, 1981

this relationship for the N.E. study area in 1981. The following summary shows that the linear interrelationship is weak in the west study area.

TABLE 6.2

Mode Split Vs. Scheduled Transit Travel Time

to the Central Area

FROM/YEAR	MSE	CORR.	R-SQUARED
N.E./1981	60	-0.61	0.371
N.E./1976	80	-0.70	0.488
WEST/1981	245	-0.48	0.230
WEST/1976	184	-0.42	0.174
S.W./1981	242	-0.67	0.445
S.W./1976	239	-0.47	0.221

The degree of linear interrelationship between mode split and the selected independent variables is small at this aggregation level and no causal effects are implied. Rather than look for distinct relationships in a behavioral environment, it was felt that a general analysis of regression envelopes should be undertaken.

6.2 The Analysis of Regression "Envelopes"

For each of the regression plots previously mentioned, an envelope was traced and envelopes from other study areas and/or census years were superimposed to facilitate comparisons. Statistics are presented for C.B.D., central and university destinations. The central area includes the Government Centre which enjoys subsidized parking, whereas the C.B.D. area (zones 12 and 14) typically does not. The results of the envelope superposition are displayed in

Appendix C of Working Paper No. 10 on file in the Transportation Engineering Library, Department of Civil Engineering, University of Alberta. A representative example is shown in Figure 6.3.

The scattergram envelopes give a graphical interpretation of the range of data points and give insight into the changes that have occurred over the study period. Vuchic(11) used envelopes to illustrate the domain of transit mode classes on capacity-frequency, capacity-speed and cost-capacity diagrams. In this study, the envelope represents a generalization of a data set. Through superposition, a comparison can be made based on the perceived characteristics of the samples. The analysis in the preceding section revealed that relationships between selected variables are weak in nature. The scatter associated with the investigated relationships is predictable, since this study is dealing with behavioral travel characteristics. This makes it difficult to identify trends by comparing regression lines or by evaluating statistical indicators. Envelope analysis is a simplistic alternative which gives the reader an instantaneous visual impression of similarities or differences between data sets.

The major trends uncovered by the analysis of the data envelopes are:

(i) An increase in mode split for central destined trips from the northeast study area between 1976 and 1981.

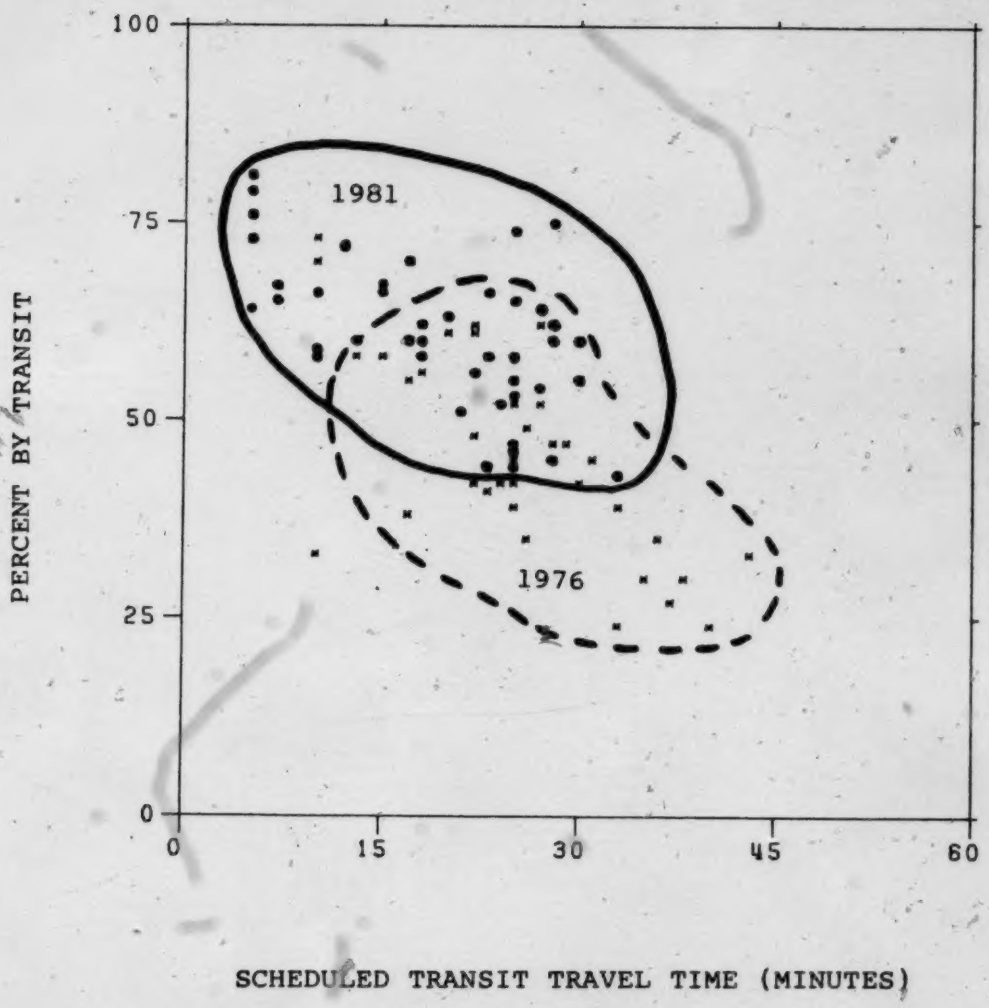


Figure 6.3 Regression Envelopes of Mode Split Vs. Scheduled Transit Travel Time to the Central Area, Northeast Study Area

(ii) An increase in mode split for central and university-destiined trips from the west study area between 1971 and 1976 with no significant change in 1981.

(iii) A decrease in transit travel time to the downtown and to the university from the northeast study area between 1976 and 1981.

(iv) A decrease in transit travel time to the university area from southwest origins between 1976 and 1981.

(v) An increase in mode split for university-destined trips from the southwest study area between 1976 and 1981.

From this simple investigation of scattergram envelopes, general trends can be identified. Armed with a preparatory understanding of the database, this research now examines the use of graphical and geographical analysis techniques.

6.3 The Presentation of Zonal Statistics on a Geographical Base

An assembled database does not, by itself, enlighten anyone. In order to discover intrinsic relationships within the database, a researcher must process the raw data and present information in a form which allows for interpretation. A carefully prepared summary table is useful for the conveyance of information, but relationships between parameters are difficult to decode.

A carefully-prepared graphic can allow for the visual perception of real world data while at the same time minimizing the distortion inherent in the decoding process. Zonal statistics take on meaning when they are presented on a geographical base. Literature states that "Maps are communicative devices which perform a myriad of functions, and the serious map-reader commonly uses a map for one or more of three purposes".(8) They are:

(i) overview - identification of general trends
(ii) tabular - a source of information
(iii) boundary - the comparison of shading patterns with those of other maps.

In this research, transportation-related statistics have been assembled at the traffic zone level of aggregation for the years 1971, 1976 and 1981. The presentation of these areal statistics on a geographic base allows for visual analysis of spatial variation and trends.

6.3.1 Mapping Alternatives

A variety of computer mapping packages are available at the University of Alberta and an investigation was performed to determine their applicability to this research. The mapping alternatives were:

(i) Computer-aided design (CADDS 4 by Computervision)
(ii) SYMAP

(iii) SURFACE II
(iv) GIMMS

6.3.2 Computer-Aided Design

In 1983, the University of Alberta acquired a computer-aided design (CAD) system. This system, managed by the CAD Group, Department of Electrical Engineering, University of Alberta, was accessible to all registered engineering students who had taken an introductory seminar on its use.

The system was manufactured by Computervision Canada Inc. and the software used at the time was the CADDS 4 version. The author became interested in this alternative when it was discovered that the system had mapping capabilities. The mapping software performed polygon management and attribute management functions. After completing the introductory course, the author began to experiment with the CADDS 4 mapping software.

The first task involved in producing a thematic map was the construction of a polygon network. This was achieved by digitizing polygon vertices as shown on a 1:40000 base map and connecting these vertices with a sequence of nodal lines. When a nodal line network was completed, a command was issued to create polygons within the database. Properties such as area, perimeter and a polygon reference number were automatically attached to each polygon generated. It was then possible to attach properties and property values to each polygon. For example, it was possible to define a property called "modesplit" and assign a value to it. A process called conditional marking could be used to highlight polygons which satisfy logical conditions imposed by the user.

Experimentation with the computer-aided design system was discontinued when it became apparent that the time required to develop a database for three census years would exceed the time allotted for this analysis phase. Factors which affected production included:

(i) familiarization with an operating system and syntax

(ii) lack of trained consultants familiar with the mapping software

(iii) system malfunctions and delays caused by system upgrading

(iv) time consuming, hand-enter style of input procedures.

An efficient means of transferring data from the university mainframe directly into the CAD mapping system would make this alternative viable for one-man research. At the time of investigation, this option was not readily available. This facility has considerable potential as a research and information management tool since it has the capacity to store transportation-related statistics within a common geographically-related database. This would enable a user to access, update and maintain an inventory of transportation-related information which could assist transportation planners in the future.

6.3.3 SYMAP

The Harvard University's Laboratory for Computer Graphics and Spatial Analysis has developed a computer mapping program called SYMAP and the program version 5.20 is available for use through Computing Services at the University of Alberta. SYMAP is an acronym for Synographic Mapping System and was developed by Howard T. Fisher in 1963. The purpose of the software is to graphically display areal data on a line printer as either a contour, conformant or proximal map. As such, it seemed suitable for the presentation of the transportation-related statistics used for this research.

Investigation into the use of program SYMAP revealed that geographic co-ordinate strings defining traffic zones were to be used as an input value. This data was available in the form of polygon files originally used for the geocoding process. The SYMAP convention is to place the origin in the upper left-hand corner of a map sheet and positive increments occur to the south and east. A simple transformation was applied to the Universal Transverse Mercator co-ordinates in the polygon files to make them consistent with the SYMAP convention. Non-geographic information was input in free-format and several test maps were produced. The use of SYMAP was discontinued after several test runs due to the poor resolution associated with line printer output. Software which had digital plotting capabilities was sought.

6.3.4 GIMMS

GIMMS is a flexible mapping system which is used to analyze geographic data and produce thematic maps and tabular information. The GIMMS system is accessible through Computing Services at the University of Alberta and has digital plotting capabilities. GIMMS (Version 3.0) was developed by Thomas C. Waugh at the University of Edinburgh. This software was chosen for the geographic presentation phase of this research because it is simple to operate and has good plotting capabilities.

The first step in the creation of a computer-drawn choroplethic map is the creation of a basefile or boundary file which is the geographic base of the map. Usually this file consists of polygons or zones which together provide a recognizable geographic reference. The boundary file for this study consists of the traffic zone system as described by polygon files used in the geocoding of civic census data. A polygon file is nothing more than a string of X-Y co-ordinates which describe a closed polygon zone.

The co-ordinate base for the polygon zones is the 6 degree Universal Transverse Mercator system. The polygon files were transformed into a form acceptable to program GIMMS and a basemap was created using the *CREATEFILE command referenced in the GIMMS users guide. This boundary file becomes the reference for subsequent statistical mapping.

A one-to-one correspondence must then be developed between each polygon zone and its relevant statistics. It is advantageous to sort both the polygon file and the statistic file into ascending numeric order at the outset. Using the *MAP command with proper symbolism options, a thematic plot description file is created and sent to the digital plotting system. An example of a complete GIMMS command file is included in Appendix C.

The following parameters were displayed against a traffic zone base:

(i) Mode Split to the Central Area (Zones 11-32 inclusive) for 1971, 1976 and 1981
(ii) Mode Split to the C.B.D. (Zones 12 and 14) for 1971, 1976 and 1981
(iii) Mode Split to the University Area (Zones 603 and 604) for 1971, 1976 and 1981
(iv) Average Household Income, 1980
(v) Scheduled Transit Travel Time to the C.B.D. for 1976 and 1981
(vi) Scheduled Transit Travel Time to the University for 1976 and 1981
(vii) Employee Density, 1971, 1976 and 1981
(viii) Bus Stop Density, 1983

A full set of colored thematic maps are contained in

Working Paper Eleven, on file in the Transportation Engineering Library, Department of Civil Engineering at the University of Alberta. Mode split statistics are presented in 5-class intervals which show overall trends and in 10-class intervals which present finer detail. 1971 and 1976 statistics share the same polygon base map and 1981 statistics are presented on the 1981 polygon network. Zones outside the three study areas have been assigned a null value with blank shading. A visual analysis was performed and similar statistics from different base years were compared. Representative samples are shown in Figure 6.4 and 6.5 and a complete 5-class grey-tone set is shown in Appendix C.

6.3.5 Mode Split to the Central Area

6.3.5.1 1971 Versus 1976

The 1971 map shows an average mode split of approximately 50% with higher mode split occurring near the city centre. The 1976 map shows an increase in mode split values to between 60-80% along well serviced transit routes and near transit centres.

6.3.5.2 1976 Versus 1981

Mode split has increased in all three study areas, but the major increase has occurred in the north-east area in the proximity of the L.R.T. right-of-way. West and southwest study areas continue to display high mode split

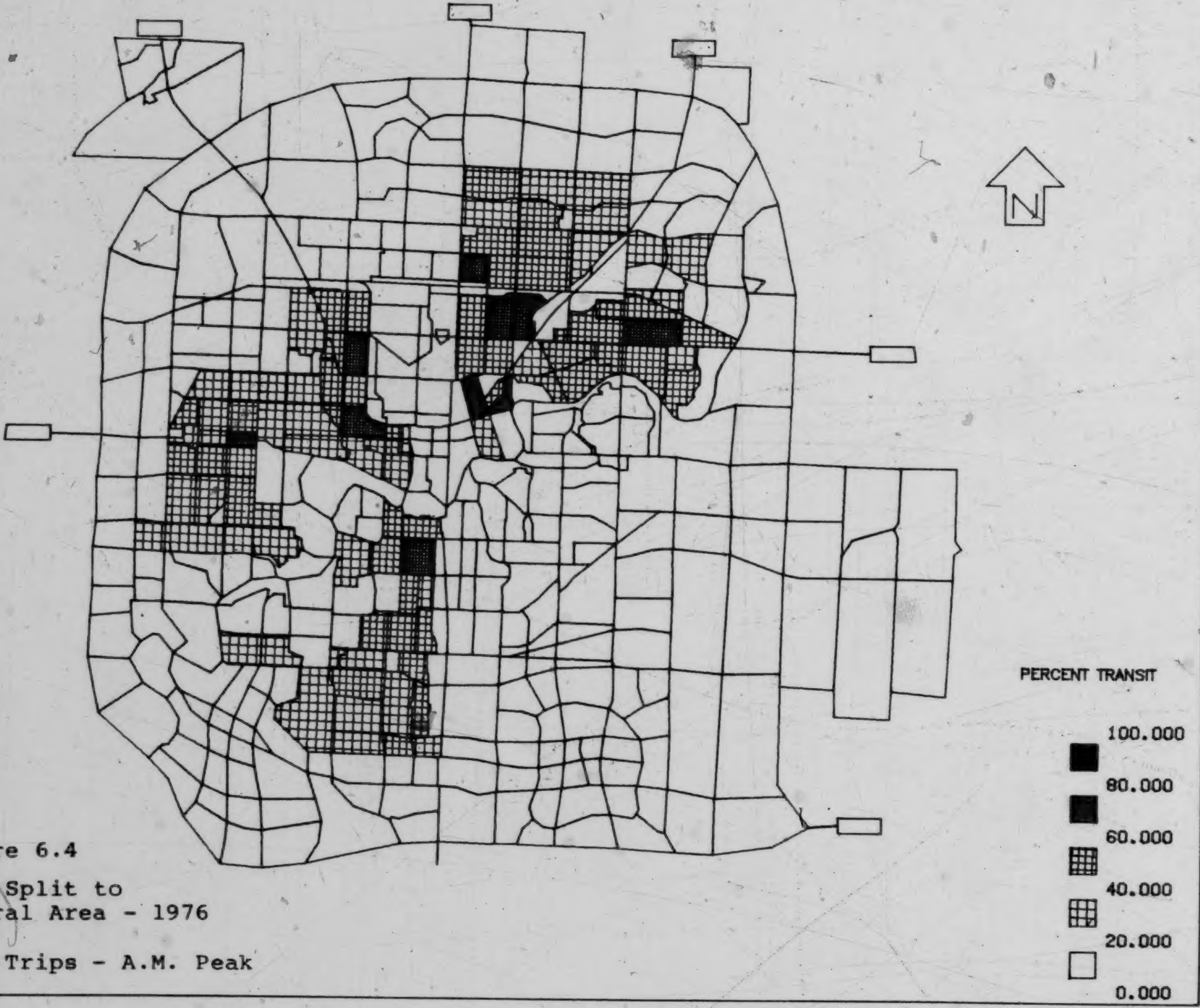

N
PERCENT TRANSIT
100.000
80.000
60.000
40.000
20.000
0.000

Figure 6.4

Mode Split to
Central Area - 1976

Work Trips - A.M. Peak

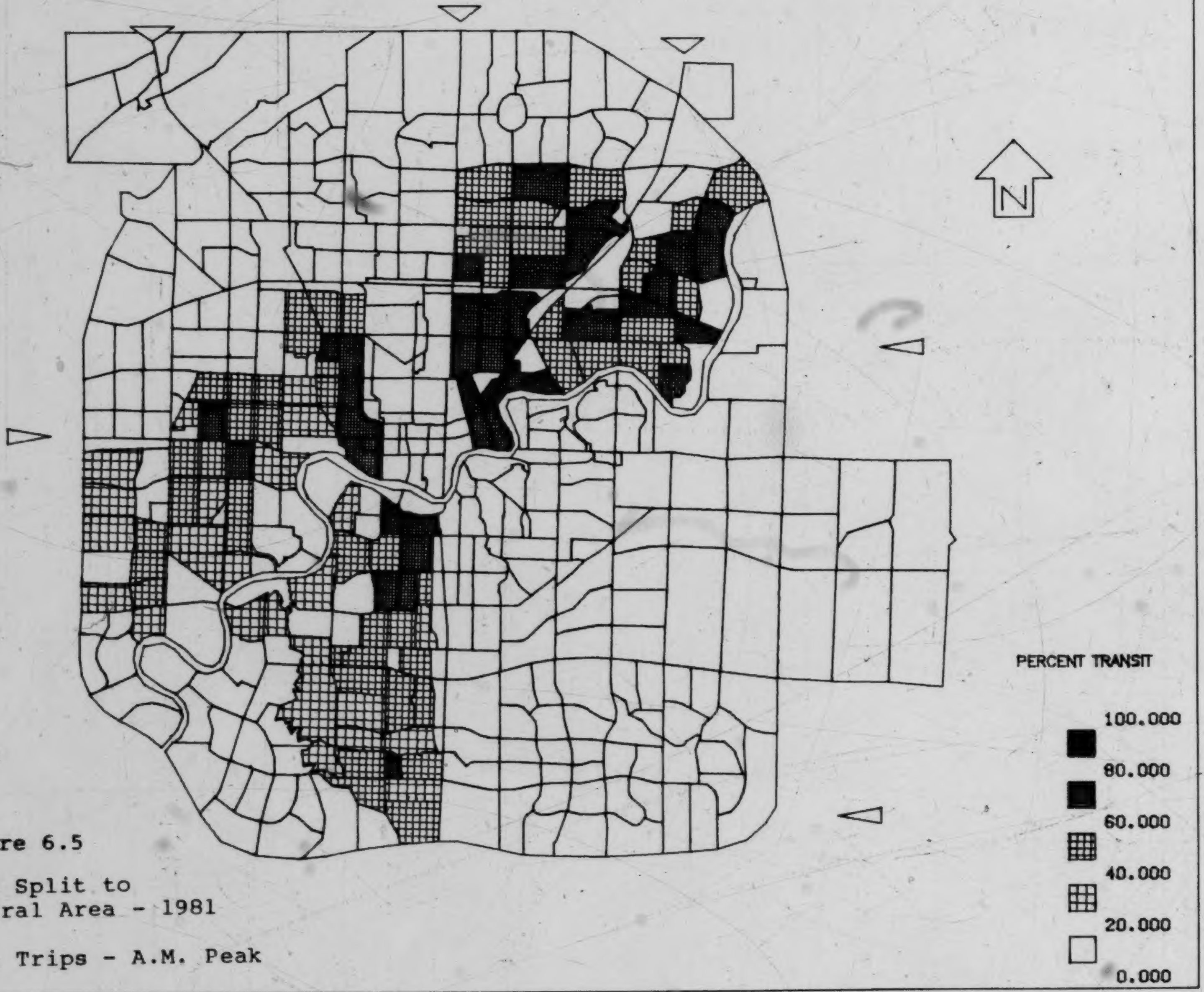

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Figure 6.5

Mode Split to
Central Area - 1981

Work Trips - A.M. Peak

along well serviced transit routes and near transit centres.

6.3.6 Mode Split to the C.B.D.

Mode split figures for C.B.D. destinations are somewhat less reliable than figures for central-destined areas because of a smaller sample size. Zones which displayed a standard deviation of ±15% were rejected from the sample.

6.3.6.1 1971 Versus 1976

The mode split to the C.B.D. in 1971 seems to be higher than mode split to the central area. Mode split also appears to be higher in the northeast than in other study areas. An increase is evident in the Jasper Place area between 1971 and 1976.

6.3.6.2 1976 Versus 1981

Once again, an increase in mode split in the northeast is evident, primarily near L.R.T. stations and adjoining the L.R.T. line. Mode split has also increased in the southwest study area along the transit corridor joining Kaskitayo, Southgate and the C.B.D.

6.3.7 Mode Split to the University Area

Since the number of trips to the university area is quite small at the traffic zone level of aggregation, the standard deviation of the mode split for this statistics is again higher than for central-destined trips.

6.3.7.1 1971 Versus 1976

Mode split to the university in 1971 was found to be relatively low with the highest values found in the northeast area. In 1976 there appears to be an overall increase with highest values occurring near transit centres like Jasper Place, Northgate and Westmount.

6.3.7.2 1976 Versus 1981

In 1981, mode split increased in the Meadowlark and Southgate areas with little change elsewhere. A slight decrease in mode split was evident in Jasper Place and Beverly areas.

6.3.8 Average Household Income, 1980

The northeast study area has the least average household income. The west and southwest regions (particularly Lessard and Riverbend areas) display higher income regions.

6.3.9 Scheduled Transit Travel Time to the C.B.D. and University

While west and southwest study areas display slight improvements if any, the northeast area shows a ten to fifteen minute decrease in scheduled transit travel time to the C.B.D.

Scheduled transit travel time to the university area has remained relatively constant in the west between 1976 and 1981. An approximate ten-minute decrease in scheduled transit travel time has occurred in southwest zones south of Whitemud Drive in 1981. Trips to the university area from northeast zones have decreased by ten to fifteen minutes between 1976 and 1981.

These findings show that a system upgrading has taken place in the service from Southgate to the University between 1976 and 1981. The effect of light rail transit in reducing travel time is highlighted by this form of analysis.

6.3.10 Bus Stop Density and Employee Density

Bus stop density statistics were seen to be uniformly distributed throughout the study areas. This was expected since in Edmonton, bus stops are placed along routes at designed intervals which try to constrain walking distance to a 450 m maximum. Transit service is usually supplied to new neighborhoods as soon as they reach final development stages.

Employee density was seen to be reasonably uniform throughout all study areas in 1971, with high density occuring in the Oliver and Garneau areas, along Saskatchewan Drive in the Strathcona area and along Jasper Avenue near 82nd Street. In 1976, employee density increased in the northeast and southwest study areas and little change occured between 1976 and 1981 except for outward expansion.

6.3.11 Errors in Thematic Mapping

When displaying statistical quantities on thematic maps, real data values are hidden within a class interval. The map becomes a class generalization of the real-world information. The error associated with the generalization depends on the number of class intervals selected and the classification method.

The classification method is usually one of four main types:

(i) equal intervals
(ii) unequal intervals based on "natural breaks"
(iii) unequal intervals based on statistical groupings
(iv) no intervals; classless maps with quantized grey-scale values.

When a small number of classes are used the error (difference between the actual value and the class interval mean) becomes larger and the map becomes more generalized. Maps with a large number of classes also pose a problem in that the eye's ability to process multiple patterns is limited.

The selection of intervals has always been a problem for cartographers. Clearly, one must avoid the placement of bias, known or unknown, into a map presentation. The method employed in this research was to use equal class intervals, divided into rounded groups. For example, the mode split statistics range from 0 to 100 and in this analysis five groups of 20% and ten groups of 10% were used for presentation. It is known that this method does not always reflect the true distribution of the data; however, the map-reader must be made aware of this fault so that he does not associate the generalized statistic with the true value of the statistic. The intent in this research is to provide an overview of the spatial distribution of transportation-related statistics. The five-class presentation of mode split achieves this purpose. For map readers who desire a more detailed knowledge of the mode split in specific zones, the ten-class data maps are available as are tabular summaries.

6.3.12 Surface II

Experimentation was performed with the Surface II graphics system, created by Robert J. Sampson, Research Associate, Computer Services Section, Kansas Geological Survey at Lawrence, Kansas. This program was designed to produce displays of spatially distributed data, either in planimetric contour form or in the form of perspective block diagrams. Particular interest was taken in the production of perspective block diagrams since it was felt that three-dimensional representations could, along with thematic mapping, give a visual sense of scale to transportation-related statistics. After several trial plots, an example of which is shown in Figure 6.6, use of this software was discontinued since the digital plots appeared cluttered and incomplete. The geographic patterns set forth by the

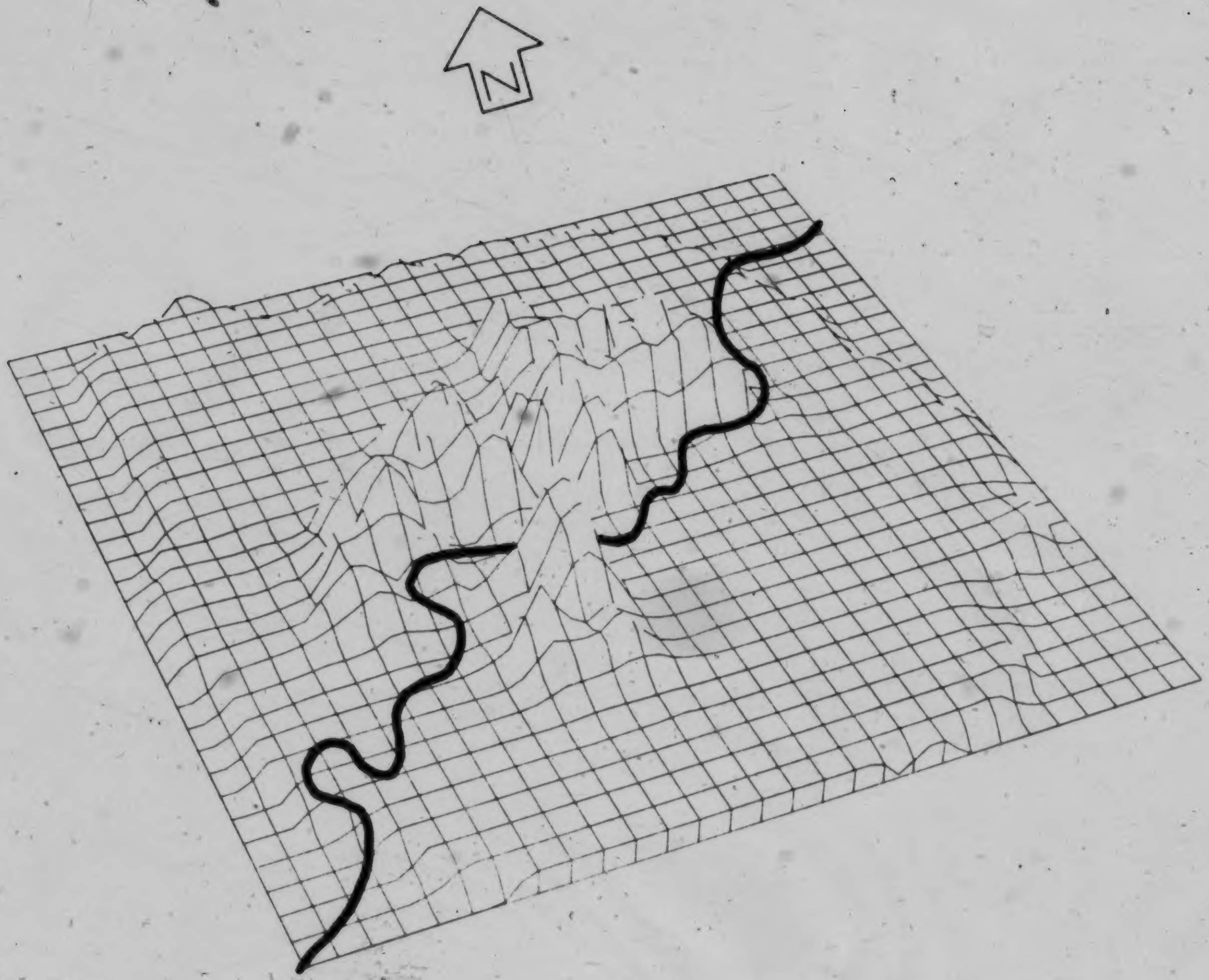

Figure 6.6 Surface II Plot of Mode Split to the Central Area, Northeast, West and Southwest Study Areas, 1971

traffic zone system was distorted by the third dimension, leaving the map-reader disoriented. Software which could present the third dimension in the form of stacked polygonal prisms would help to solve this problem, if a plan view illustrating zonal shapes were provided as an inset reference. A three-dimension presentation of this type may be possible using computer-aided design (CAD) systems; however, time did not allow for experimentation of this type.

6.4 Time Series Analysis

The yearly summary files for 1971, 1976 and 1981 were merged using traffic zone numbers as a common identifier. During the merging process, a tabular summary was produced for zones which have had a development history dating back to 1971. The tabular summary is presented in Appendix D. The zonal statistics chosen for tabular presentation include:

(i) Population
(ii) Employees
(iii) Households
(iv) Acreage
(v) Mode Split to Selected Destination Zones
(vi) Transit Trips to Selected Destination Zones
(vii) Transit Trips per 100 Households
(viii) Employee Density

Values in the tabular summary coded with -1.0 indicate missing data. In many cases the transit trip sample size was too small to effectively report a mode split estimate.

An analysis of the tabular summaries indicated that acreage values for all traffic zones were not constant over the time period chosen. Acreage has been computed from coordinate values found in the polygon files associated with the census geocoding process. Traffic zone boundaries have not remained static over the time segment. Minor modifications have sometimes been made to compensate for development and redevelopment within the zones and to agree with enumeration district boundaries. In other cases (such as the Bellevue-Highlands district) a complete reorganization of zonal boundaries has occurred.

An effective time-series comparison could only be made with zones that have had constant boundaries over the chosen time segment. An arbitrary acreage tolerance of plus or minus ten acres was imposed on the tabular summary list and the following traffic zones as shown in Table 6.3 met the criteria.

In this reduced set of 41 zones, bar charts were prepared outlining trends in zonal statistics. An IBM personal computer with ENERGRAPHICS (Enertronics Research Inc., St. Louis, Missouri) software and a Hewlett-Packard 7470 plotter was used to produce multiple bar charts. A representative sample is shown in Figure 6.7 and a complete set of charts is contained in Working Paper 12, contained in the Transportation Library, Department of Civil Engineering

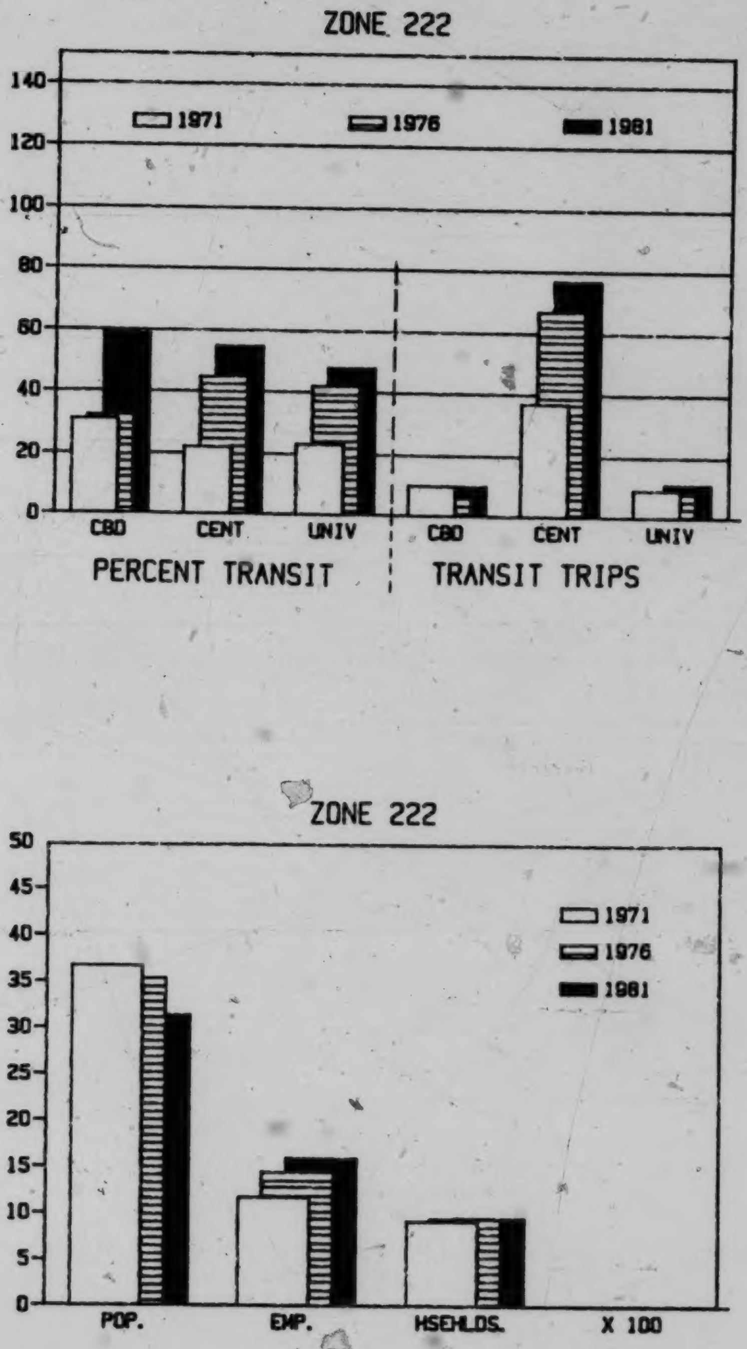

Figure 6.7 Representative Sample of Bar Chart Plots Used in the Time Series Analysis Phase

TABLE 6.3

Traffic Zones Which Display Constant Boundaries

Northeast		West		Southwest	
Zone	Community	Zone	Community	Zone	Community
84	Woodland	411	Dovercourt	605	Garneau
85	Delton	421	Woodcroft	611	Belgravia
86	Eastwood	423	Sherbrooke	632	Landsdowne
91	Norwood West	424	North Inglewood	633	Michener Park
92	Norwood East	432	Westmount	651	Royal Garden
101	Queens' Avenue	433	Groat Estates	681	Pleasant View
103	Stadium	434	Groat Estates	682	Pleasant View
131	Beverly North	441	Victoria Park	691	McKernan
132	Beverly	444	Oliver	692	McKernan
201	Belvedere	461	McQueen	694	Martin Estate
212	Balwin	462	North Glenora		
222	Londonderry South	463	West Croft		
273	Killarney	464	Glenora		
274	North Delton	471	Mayfield		
		473	Youngstown		
		494	Balmoral		
		511	Elmwood		

at the University of Alberta. Visual inspection of the charts allow the reader to gain a sense of scale and proportion which is not readily evident in summary tables.

The time series analysis technique assists in the identification of changing transit travel characteristics in discrete geographic locations within the study areas. The general trends that are evident amongst older, established zones are:

(i) declining population

(ii) an increasing number of employees

(iii) a slight increase in the number of households

(iv) a decrease in the number of zonal transit work trips made in A.M. peak conditions.

The time series summaries show a decrease in population per household and an increase in employee density over the period 1971-1981 which is consistent with the known tendency towards smaller families and two-income households. Associated with the population decline in older, established zones is a decrease in the number of A.M. peak work transit trips. The percentage of trip-makers using the transit mode has, however, either remained constant or increased over the time segment. It is presumed that as a community grows older, the household family size grows smaller. The number of work trips decline as senior family members retire and post-secondary students leave home, putting less demand on A.M. peak transit work trips. The question of whether total transit ridership has declined on a regional basis then arises. The cohorts which have "grown out" of their origin zone must migrate out of the city or relocate within city boundaries. Over the time period selected for this study, residential growth has occurred on Edmonton's periphery in such areas as Millwoods, Hermitage, Castledowns and Primrose to name a few.

It is beyond the scope of this research to determine the migration behaviour of transit riders. Time-series information, however, allows the determination of transit work trip production statistics for an entire study area over the period 1971-1981. These statistics are summarized in Tables 6.4, 6.5 and 6.6 and are depicted in Figures 6.8, 6.9 and 6.10 on the following pages.

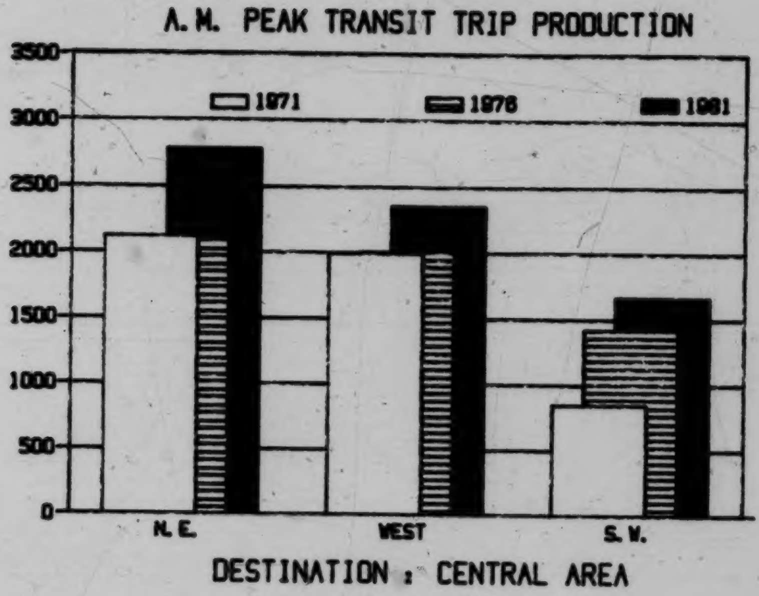

Figure 6.8 Peak Period Transit Work Trip Production (1971-1981) for Central Area Destinations

TABLE 6.4

Peak Period Transit Work Trip Production (1971-1981)

DESTINATION: CENTRAL AREA

	Northeast	West	Southwest
1971	2113	1984	841
1976	2077	1996	1416
1981	2774	2345	1659

During the selected time segment, morning peak period transit work trips destined to the central area have increased. The northeast area showed a slight (1%) decrease in 1976 but showed an above average (33%) increase between 1976 and 1981.

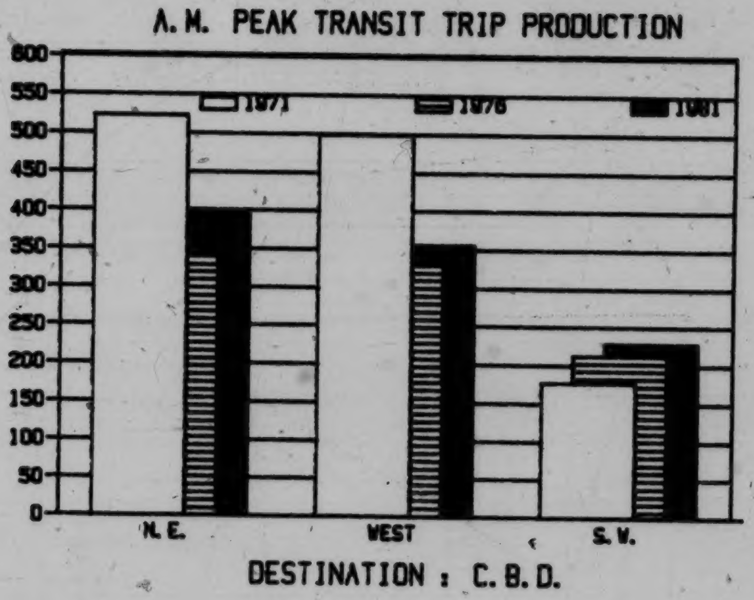

Figure 6.9 Peak Period Transit Work Trip Production (1971-1981) for C.B.D. Destinations

TABLE 6.5

Peak Period Transit Work Trip Production (1971-1981)

DESTINATION: CENTRAL BUSINESS DISTRICT

	Northeast	West	Southwest
1971	520	496	177
1976	337	328	212
1981	397	354	227

Except for the southwest area, morning peak period transit work trips to the Central Business District have decreased between 1971 and 1976. All study areas show a slight increase between 1976 and 1981.

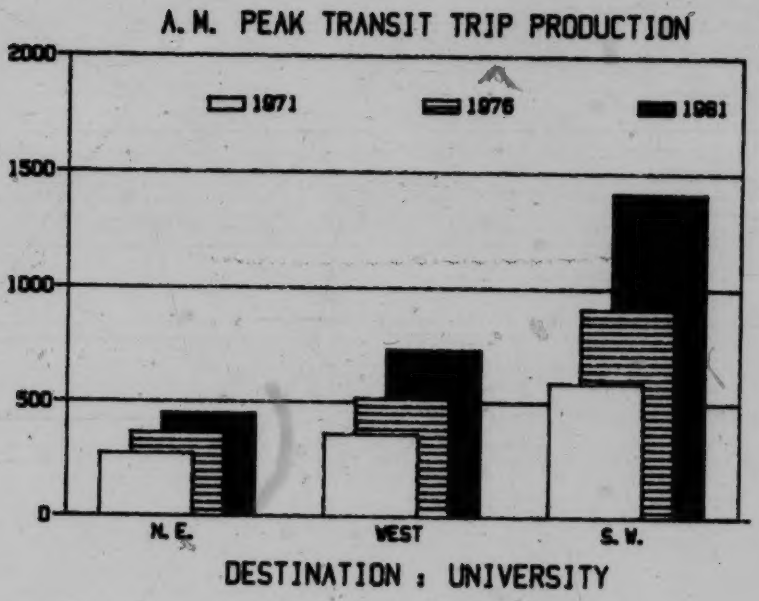

Figure 6.10 Peak Period Transit Work Trip Production (1971-1981) for University Destinations

TABLE 6.6

Peak Period Transit Work Trip Production (1971-1981)

DESTINATION: UNIVERSITY OF ALBERTA

	Northeast	West	Southwest
1971	274	359	588
1976	365	516	911
1981	449	730	1411

The number of northeast based morning peak period transit work trips has increased by approximately 28% per year. Similar increases for the west and southwest study areas are 43% and 55% respectively.

The time series analysis of A.M. peak period transit trip production over the study regions has identified that the number of work trips to central destinations has increased over the study period and that the most significant increase has occurred in the northeast area. Trips to the central business district have increased between 1976 and 1981; however, a substantial decrease was observed between 1971 and 1976 in the northeast and west study areas. University-destined transit trips have shown a steady increase over the study period from all three study areas, with the southwest area showing the highest rate (55% per year) of increase.

6.5 Control Area Comparisons

The control area comparison analysis technique was used to study and identify the inherent characteristics of regions which could be categorized as either within or without the influence of light rail transit development.

The western control area was chosen in the preliminary analysis and control area selection phase as a region which displayed characteristics which were similar to the northeast study area. The southwest control area has less in common with the study area; however, it was selected more as a special interest area in that light rail transit development is proposed for that region in the immediate future. Both the western and southwest control areas are currently without light rail transit influence.

6.5.1 Group Comparison

In the comparison process, similar zones from the study area and the western control area were analyzed to see what changes have occurred in demographic and trip-related statistics. The selection of "similar" zones was based on the following criteria:

- (i) socio-economic status
- (ii) employee density
- (iii) similar demographic profiles.

Only zones which displayed a ±10 acre tolerance in acreage were included in this comparison. The socio-economic indicator chosen was 1980 average household income, obtained from the 1981 Census of Canada. The following table lists zones from the study area and the control area, sorted by increasing annual household income.

TABLE 6.7

Control Comparison Zones

N.E. Study Area		West Control Area	
Zone	Average Household Income	Zone	Average Household Income
101	18,700	412	18,700
85	21,100	434	19,300
92	21,700	473	21,100
84	21,800	441	22,200
91	22,100	444	22,200
86	22,300	432	23,900
132	22,500	433	23,900
273	23,900		
201	24,000		

From the tabular summaries produced for the time series analysis, percent change statistics were computed for the above-mentioned zones. These statistics are presented in Table 6.8, shown on the following page. This tabular summary includes two zones from the western control area (zones 444 and 473) which have similar income characteristics but do not fit into a decreasing demographic pattern. An average value is presented with these zones excluded and the following trends are evident:

(i) Population is decreasing in both areas at a rate of approximately 10% per 5 year interval.

(ii) The number of employees per zone is increasing. Most of the increase occured between 1971 and 1976.

(iii) The number of households per zone is constant over the selected time period.

(iv) Mode split to the C.B.D. dropped or remained constant between 1971 and 1976 and increased between 1976 and 1981. The study area showed a slight (7% on average) advantage over the control area between 1976 and 1981.

(v) Mode split to the central area has increased by approximately 12-15% over the time period 1971-1981. There seems to be no appreciable difference between study and control area.

(vi) Mode split to the university area improved in both areas by approximately 10% between 1971 and

TABLE 6.8

Control Area Comparison Percent Change Statistics

Traffic Zone	Northeast Area										West Area								
	84	85	86	91	92	101	132	201	273	Avg	412	432	433	434	441	444	473	Avg	Avg w/o zones 444 and 473
Population 1971-1976	-11	-7	-10	-12	-12	-14	-11	-4	-13	-10	-15	-6	-16	-7	-9	34	12	-1	(-11)
Population 1976-1981	-7	-1	-14	-11	-16	-8	-7	-12	-12	-10	-13	-8	-8	-11	-15	-9	-12	-11	(-11)
Employees 1971-1976	9	11	9	12	17	33	17	17	17	16	11	14	11	20	27	54	52	27	(17)
Employees 1976-1981	11	19	1	2	3	17	8	6	2	8	-1	4	11	6	-10	11	4	4	(2)
Households 1971-1976	-5	2	5	-7	-4	11	0	11	-2	1	-1	6	0	9	2	45	36	14	(3)
Households 1976-1981	4	11	-1	2	0	16	8	-9	1	4	-1	2	8	3	-3	-1	0	1	(2)
% Transit-CBD 1971-1976	12	-6	18	-6	-7	-	-9	-46	-30	-9	7	2	-12	11	-	-45	-	-7	(2)
% Transit-CBD 1976-1981	6	12	11	14	7	-	6	46	23	16	22	9	1	5	-	29	-	13	(9)
% Transit-Central 1971-1976	7	19	14	2	4	23	15	-19	7	8	6	13	-7	2	16	-16	20	5	(6)
% Transit-Central 1976-1981	12	-1	10	7	7	-9	-4	42	2	7	17	9	1	14	-11	31	-13	7	(6)
% Transit-University 1971-1976	-	4	0	15	29	1	29	16	-12	10	4	22	-3	22	-	5	-	10	(11)
% Transit-University 1976-1981	-	11	13	-4	-29	18	-3	9	-14	0	12	-17	1	12	-	27	-	7	(2)

1976. No appreciable change occurred between 1976 and 1981.

The reader should realize that the average values used to provide the above-mentioned trends are based on a small sample of zones that are similar in terms of income and demographic behavior. The sample size is limited due to two primary reasons:

(i) A lack of zonal boundary continuity. Acreages were not constant over the time period selected due to boundary changes.

(ii) An ambiguous demographic pattern. This is typified by an unusual "peak" or "valley" in 1976 population figures. The unreliability of certain 1976 census data has been previously discussed in Section 4.2.

6.5.2 Area-wide Comparison

If one disregards the above-mentioned problems and treats each zonal mode split statistics as a discrete sample independent of zonal boundary characteristics, a much larger sample size is developed. The only constraint placed on the sample is that it should contain zones which are established with respect to residential development, over the time period 1971-1981. This sample is identical to the tabular summary used in the time series analysis. Average mode split values were computed for northeast and west peak period trips to C.B.D., central and university destinations. Tables 6.9 and 6.10 illustrate the change in mode split over the time period and the differences between the study and control areas. Figure 6.11 and 6.12 display the statistics in graphical form.

These tables, which are based on a much larger sample than previously discussed in this section, identify the following trends:

(i) Mode split has always been higher in the northeast study area.

(ii) Transit usage has generally improved or remained constant over the time period 1971-1981.

(iii) Mode split to the C.B.D. from the study area increased by 13% between 1976 and 1981. The equivalent control area statistic was 6%.

(iv) For central-destined trips, the study area shows an increase of 12% between 1976 and 1981. The equivalent control area statistic was 7%.

(v) The most significant improvement for university-destined mode split occurred between 1971 and 1976. An 18% increase in mode split was realized in both areas within this time period. During 1976-1981 the western control area has shown further improvement whereas mode split in the northeast area has remained constant at a higher rate.

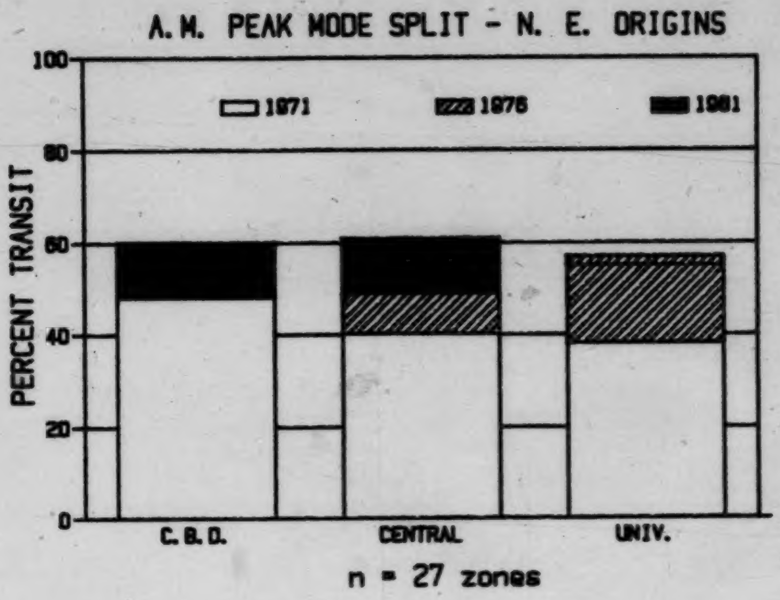

Figure 6.11 Trends in Mode Split, Northeast Study Area

TABLE 6.9

Trends in Mode Split - Northeast Study Area

	Destination		
	C.B.D.	Central	University
Average Mode Split 1971	48%	40%	38%
Average Mode Split 1976	47%	49%	57%
Average Mode Split 1981	60%	61%	55%

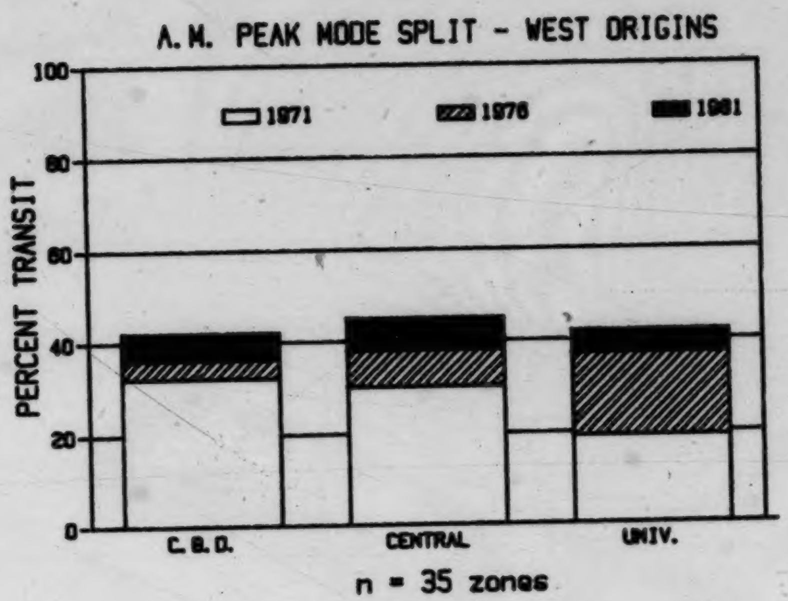

Figure 6.12 Trends in Mode Split, West Study Area

TABLE 6.10

Trends in Mode Split - West Control Area

	Destination		
	C.B.D.	Central	University
Average Mode Split 1971	32%	30%	19%
Average Mode Split 1976	36%	38%	37%
Average Mode Split 1981	42%	45%	42%

Light rail transit patrons who are destined to the university area are, in most cases, required to transfer twice during the duration of their trip. These transfers occur between the bus feeder and light rail transit and between light rail transit and a university bus service. The high frequency of service on the light rail transit line minimizes the detrimental effects of the first transfer; however, it is interesting to note that N.E.-based mode split to the university remained constant at approximately 56% between 1976 and 1981. At the same time, C.B.D.-destined mode split increased by 13%, from 47% to 60%. Clearly, C.B.D.-destined trip-makers found the public transit mode to be more attractive in 1981 than university-destined trip-makers.

The double-transfer problem may have a negative effect in this instance; however, the university has a parking service which can strongly affect mode choice. Staff is given priority in a system where demand has always exceeded supply and parking rates are low, comparatively speaking.

It is postulated that, compared to downtown trip-makers, fewer university-destined trip-makers would switch from the choice automobile mode to the choice transit mode because of the double-transfer problem and the availability of reasonably-priced staff parking.

6.5.3 One-on-One Comparison

In a further attempt to determine trends in transit travel characteristics, a one-on-one zonal comparison was undertaken. Individual zones in the study and control areas were selected based on the following attributes:

(i) employee density

(ii) demographic profiles

(iii) similar distances to destinations (radial to C.B.D.)

(iv) average household income (1980)

Three zone pairs have been selected and are presented in order of increasing distance from the central business district.

6.5.3.1 Zone 86 (Eastwood) vs. Zone 432 (Westmount)

	Zone 86	Zone 432
employee density 1981	6 emp./acre	10 emp./acre
demographic profile	declining	declining
radial distance to C.B.D.	4.5 km	4 km
avg. household income (1980)	22,258	23,923
% TRANSIT C.B.D. (71-76-81)	44-62-73	63-65-74
% TRANSIT CENT. (71-76-81)	48-62-72	54-67-76

6.5.3.2 Zone 211 (Delwood) vs Zone 495 (Meadowlark)

	Zone 221	Zone 495
employee density 1981	7 emp./acre	6 emp./acre
demographic profile	unstable	declining
radial distance to C.B.D.	6.4 km	6.0 km
avg. household income (1980)	34,211	33,287
% TRANSIT C.B.D. (71-76-81)	42-30-70	28-34-25
% TRANSIT CENT. (71-76-81)	34-42-56	22-24-26

6.5.3.3 Zone 156 (Clareview) vs Zone 484 (Primrose)

	Zone 156	Zone 484
employee density 1981	4 emp./acre	7 emp./acres
population, 1981	2297	4056
employees, 1981	1177	2071
radial distance to C.B.D.	9.6 km	9.6 km
avg. household income (1980)	28,675	31,135
% TRANSIT C.B.D. (1981)	36%	25%
% TRANSIT CENT. (1981)	60%	32%

6.5.3.4 Summary of Individual Zone Comparisons

The first zonal comparison shows two zones which are similar, except that the Westmount zone has a higher employee density. Both zones have excellent transit service in that they are adjacent to transit terminals. These zones also show similar (high) mode split statistics for 1976 and 1981.

The second zonal comparison illustrates two zones which are further away from the C.B.D. The Meadowlark zone shows low mode split figures despite its proximity to a transit centre. The northeasterly zone shows higher mode split figures overall and shows a major increase between 1976 and 1981.

Finally, the third comparison itemizes two zones which are 10 kilometers away from the C.B.D. and are in regions of recent development. Employee density was found to be much higher in the Primrose area; however, the ratio of population to employees was identical at 2.0. 1980 average household income was slightly higher in Primrose than in the Clareview area and the Clareview area has a higher level of transit service. Scheduled transit travel time downtown (1981) for Zone 156 was approximately 30 minutes whereas Zone 484 had a travel time of approximately 40 minutes. Mode split figures are significantly higher in the Clareview areas.

Due to the inherent differences between zones in different study areas, one-on-one zone comparisons are not very profitable. The above comparisons seem to suggest that transit travel time and transit accessibility are important factors affecting mode split.

7.0 IDENTIFIABLE TRENDS

During the data analysis phase, it became evident that certain trends have been developing over the time segment in transit travel characteristics and demographic statistics. This chapter will serve to summarize these trends and discuss their implications with respect to light rail development in Edmonton.

7.1 Demographic Trends

General trends which were discovered amongst older, established zones included a declining population base and an increase in the number of employees per zone. The number of households per zone in established zones has remained generally constant over the period 1971-1981. There has been a tendancy towards fewer people per household and more employees per household.

7.2 Transit Trip Production

Time series analysis has shown an apparent decline in transit trip production in older, established zones which is assumed to be associated with the declining population base. Through investigation into transit trip production for entire study areas it was found that the number of A.M. peak transit trips to the central area has increased over the study period and that the most significant increase has occurred in the northeast area. Transit trips to the central business district have decreased in northeast and west zones between 1971 and 1976 and increased between 1976 and 1981. University-destined transit trips have shown a steady increase over the study period, with the southwest area showing the highest rate (55% per year) of increase.

7.3 Mode Split Trends

It has been shown through regression analysis that no clear linear relationship exists between mode split and the investigated parameters, although evidence of negative correlations with income and scheduled transit travel time exist.

A significant increase in mode split to the central area from northeast zones occurred betwen 1976 and 1981. Presentation of statistics on a geographic base revealed that high mode split values were associated with zones that are near well-serviced transit routes and transit centers.

Mode split has always been higher in the northeast area between 1971 and 1981 by 10% to 15%. Generally speaking, mode split has improved or remained constant over the study period.

Control area comparisons have revealed that study area mode split for C.B.D.-destined trips increased 13% between 1976 and 1981 while control area mode split increased by only 6%. This gives a net study area gain of 7%. Similar statistics for central-destined trips show a study area gain of 5%. University-destined mode split showed a major improvement (18%) in both study areas between 1971 and 1976.

The zone pairs analyzed in the individual zonal comparison showed that the zone pair which was close to the C.B.D. and had good transit service showed no appreciable difference in mode split values. The zone pair which was an intermediate (6 km) distance from the C.B.D. showed a higher mode split in the northeastern zone and a larger increase in mode split between 1976 and 1981. The peripheral zone pair showed a much higher mode split in the northeast zone.

7.4 The Effect of Transit Travel Time

Envelope analysis and the presentation of statistics on a geographic base has revealed a decrease in transit travel time (ten to fifteen minutes) to the downtown and university between 1976 and 1981, which is associated with the implementation of light rail transit. The analysis has also identified a decrease in travel time to the university area from southwest origins between 1976 and 1981. This decrease is most apparent in zones south of Whitemud Drive and is assumed to be caused by a transit system upgrade in service from the Southgate transit terminal to the University.

In 1969, Gill(3) reported that "every effort should be made to reduce total travel time". He went on to mention that careful location of bus stops and the implementation of direct routes without transfers or direct routes with timed transfers could achieve this goal. This research has shown that of all the parameters investigated, income and scheduled transit travel time display the highest degree of linear interrelation with the mode split variable in a regression analysis. The presentation of statistics on a geographic base has shown that high mode split zones occur primarily along well-serviced transit corridors. In the morning peak period environment which has been used in this study, the frequency of service is excellent with headways of five to fifteen minutes along such corridors. Problems associated with schedule reliability are minimized under such conditions. The zones which display high mode split are typically in areas which do not require a transfer. Transfers, when required, are either timed or are connected to a route with frequent service, thereby minimizing transfer time.

7.5 Implications With Respect to L.R.T. Development

The implementation of an integrated light rail transit system in April, 1978 represents the most important transit system improvement in Edmonton's history. Unlike other metropolitan cities which use light rail transit, Edmonton has not encountered high density residential development along the rail line or near transit stations because of the nature of the right-of-way and current leasing arrangements. Ridership is "collected" from a network of bus feeder routes and park-and-ride patrons from outer residential expansion zones.

The trends which have surfaced during this research have implications with respect to light rail transit development in Edmonton. After the implementation of the Northeast Light Rail Rapid Transit Line, northeast area mode split to the downtown area increased by ten to fifteen percent as evidenced by a comparison of 1976 and 1981 census information. Control area comparisons have shown a net increase of 6% over a similar area in West Edmonton between 1976 and 1981.

Non-system related factors which might place the northeast study area in an advantageous position concerning the capture of transit patrons include:

(i) lower income levels, which is usually associated with captive ridership

(ii) more rapid residential growth in outer northeast zones.

The control comparison which was based on a small subset of zones which have similar income and demographic profiles seemed to disprove these suggestions. This comparison showed that for northeast-based peak period work trips destined for the C.B.D., net gain in mode split was still 7% higher on average than the identical western-based statistic. This trend is similar to the control area comparison which included zones with dissimilar income and demographic profiles.

The nature of the 1981 census questionnaire is such that it does not allow for the separation of transit system components in the northeast area. This is in keeping with the concept that light rail transit is an extension and integral part of the existing transit system (only the hardware used is different). This makes it impossible to separate those who use only bus transit to travel downtown from those who use light rail transit with bus feeders. Thus, this analysis can only suggest that the northeast study area transit system appears to be more attractive to peak period work trip commuters than the transit system in the west control area.

The mode split difference of 5-7% between areas represents only a slight trend towards higher relative mode split in the northeast area. The non-system related differences between study areas which cannot be quantified by this research should, in theory, reduce the significance of this statistic. However, given that the western transit system has not degenerated over the period 1976-1981, it seems that light rail transit has had positive impact with respect to attracting transit patrons.

In D.B. Rhyason's thesis (1967)$^{(2)}$ it was mentioned in the conclusions that:

> *"radical changes in the transit routes did not affect the overall modal split relationships. However the changes in the transit route system did increase the percentage of employees using transit by decreasing the transit travel time from most zones."*

As previously discussed, the introduction of light rail transit has brought about a marked reduction in transit travel times to major destination areas. This attribute, when combined with accessibility , efficient transfers and frequent service would tend to increase transit ridership.

8.0 CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

This goal of research was to study the changes in transit travel characteristics in Edmonton between 1971 and 1981 and to assess the impact of the implementation of the Northeast Light Rail Rapid Transit Line. Associated demographic information was analyzed and mode split was used as an indicator of transit usage. The information base for this study was comprised primarily of 1971, 1976 and 1981 census data including geo-coded origin-destination data. Other information used included scheduled transit travel times, but stop location data and average household income statistics.

An associated benefit of this research was the extraction, review and consolidation of transportation-related information into a single information base complete with graphical presentation.

Simple linear regression analysis proved that no single variable has a profound relationship with mode split, although some interrelationship exists with income and travel time. The analysis of scattergram envelopes is a swift, efficient method of determining relationships and trends amongst variables. The presentation of statistics on a geographic base allowed the spatial analysis of variables. Time series analysis helped to identify anomalies and trends while control area comparisons helped to define net increases in mode split statistics. One-on-

one zonal control area comparisons were found to be less than profitable due to the inherent differences between zones.

The analysis techniques used in this research has brought forth the following conclusions:

(i) The implementation of light rail transit has helped to increase morning peak period mode split to downtown destinations. The magnitude of this impact was seen to be five to seven percent higher than areas without L.R.T. influence.

(ii) Mode split in study areas was found to have either remained constant or improved over the study period.

(iii) Older, established zones have demonstrated declining population and transit trip production over the study period.

(iv) Transit trip production aggregated over entire study areas which include zones of new development has increased over the study period for all destination areas with one exception. Transit trips from northeast and west origins to the central business district decreased between 1971 and 1976. The most significant gain in transit ridership downtown occurred in the northeast between 1976 and 1981.

(v) High mode split zones tend to be located near major transit corridors or transit centres.

(vi) Regression analysis has shown that of the parameters examined, average household income and scheduled transit travel time have the highest degree of linear interrelationship with mode split. Employee density and bus stop densities were found to be uniformly distributed amongst the study areas.

(vii) Scheduled transit travel times have decreased over the time period as a result of system upgrading.

(viii) The use of graphics to process and convey information has greatly assisted in the evaluation of transit travel characteristics in Edmonton.

This study has also drawn attention to a number of suggestions which are offered as recommendations for further research:

(i) It is recommended that 1986 census information be added to the database used in this research to assess trends between 1981-1986. Allowance will have to be made for the effects of economic downturn experienced during this period.

(ii) 1986 census questionnaires should differentiate between public transit components in a manner similar to the suggestion put forward in section 4.2. Components could then be aggregated to conform with earlier studies.

(iii) Further investigations into the relationship between mode split and average household income, transit travel time, and transit accessibility should be made.

(iv) In as much as the extension of light rail transit to the University of Alberta has been approved, it is recommended that the future impact of this system improvement be assessed using the analysis techniques implemented in this investigation.

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APPENDIX A

SCHEDULED TRANSIT TRAVEL TIME CONTOURS

(Pages 102 through 110 deleted for microfilming purposes)

APPENDIX B

DATA MANAGEMENT: FILE INDEX AND DOCUMENTATION

FILE INDEX AND DOCUMENTATION

During the data extraction phase of this research, extraction software was written to condense information into manageable units. The source information has been referenced in Section 5.0 of this report. Extraction software and condensed data files have been stored on magnetic tape in the University of Alberta magnetic tape library as volume L172L0, rack number 007533. A listing of the files contained on this tape is presented in Table B1 and an explanation of the file contents follows.

DATA SET ONE

FILES: EXTRACT76
EXTRACT81

FILE TYPE: FORTRAN PROGRAMS

PURPOSE: To extract pertinent information from geocoded 1976 and 1981 census files, convert and condense this information into a usable form, catagorize households into study area units and prepare data for sorting and aggregation into zonal statistics.

REFERENCES: Working Paper No. 2, June, 1983
Working Paper No. 8, January, 1984
Working Paper No. 9, Spring, 1984

DATA SET TWO

FILES: ACCUM

ACCUM76

ACCUM81

FILE TYPE: FORTRAN PROGRAM

PURPOSE: To accept census data which has been extracted from geocoded census files with program "EXTRACT" and sorted into ascending traffic zone order; to accumulate (aggregate) statistics into zonal summaries; to write printed summaries and condensed output files.

REFERENCES: Working Paper No. 2, June, 1983

Working Paper No. 8, January, 1984

DATA SET THREE

FILES: EMPOP71

EMPOP76

EMPOP81TRAF

FILE TYPE: DATA FILES

DESCRIPTION: Condensed data files (output from program ACCUM), including household, population and employee statistics. Each record contains in order:

(i) Traffic Zone Number

(ii) Households per Zone

(iii) Persons per Household

(iv) Employees per Zone

(v) Employees per Household

REFERENCES: Working Paper No. 8, January, 1984
Working Paper No. 9, Spring, 1984

DATA SET FOUR

FILES: TT71TRAF
TT76TRAF
TT81TRAF

FILE TYPE: FORTRAN PROGRAM

PURPOSE: To read 1971, 1976 and 1981 trip tables, select traffic origin zones and aggregate arrivals into specific destination zones.

REFERENCES: Working Paper No. 5, September, 1983
Working Paper No. 6, November, 1983
Working Paper No. 8, January, 1984

DATA SET FIVE

FILES: TT71DATA
TT76DATA

FILE TYPE: DATA FILES

DESCRIPTION: Trip tables stored in matrix form, based on traffic zone aggregation. A.M. peak data.

REFERENCES: Working Paper No. 5, September 1983
Working Paper No. 6, November, 1983

DATA SET SIX

FILES:

NEW DESIGNATION	OLD DESIGNATION
TT71NE	NE71
TT71W	WEST71
TT71SW	SW71
TT76NE	TT76OUT.NE
TT76W	TT76OUT.W
TT76SW	TT76OUT.SW
TT81NE	NE81TT
TT81W	W81TT
TT81SW	SW81TT

FILE TYPE: DATA FILES

DESCRIPTION: Condensed trip information; arrivals at selected destinations from Northeast, West and Southwest study area origins; A.M. peak data categorized by mode; output from programs TT71TRAF, TT76TRAF and TT81TRAF.

REFERENCES: Working Paper No. 5, September, 1983
Working Paper No. 6, November, 1983

DATA SET SEVEN

FILES:

NEW DESIGNATION	OLD DESIGNATION
TTP71NE	NEPER71
TTP71W	WESTPER71
TTP71SW	SWPER71
TTP76NE	TT76.NEPER
TTP76W	TT76.WPER

TTP76SW TT76.SWPER

TTP81NE NE81TTP

TTP81W W81TTP

TTP81SW SW81TTP

FILE TYPE: DATA FILES

DESCRIPTION: Modal percentages for arrivals at selected destinations from Northeast, West and Southwest area origins; output from programs TT71TRAF, TT76TRAF and TT81TRAF.

REFERENCES: Working Paper No. 5, September, 1983

Working Paper No. 6, November, 1983

DATA SET EIGHT

FILES: ST71

ST76

ST81

FILE TYPE: DATA FILES

DESCRIPTION: Free format data suitable for input to the interactive statistical graphics package (STPK); contains both demographic and trip-related statistics; the value (-1.0) was used as a missing value indicator.

REFERENCE: Working Paper No. 10, July, 1984

DATA SET NINE

FILES:

NEW DESIGNATION	OLD DESIGNATION
DAT71	DAT71.A
DAT81	EP81.T

FILE TYPE: DATA FILES

DESCRIPTION: Data files including 1971 and 1981 zonal areas. 1976 zonal areas are included in file EMPOP76, referenced in data set three.

DATA SET TEN

FILES:
VAR71
VAR76
VAR81

FILE TYPE: DATA FILES

DESCRIPTION: Files which give the computed standard deviations of mode split (estimate of proportion) for all traffic zone peak work trips to selected destinations.

REFERENCE: Working Paper No. 10, July, 1984.

DATA SET ELEVEN

FILES:
TRAFPOLYGON
POLY83.BI

FILE TYPE: DATA FILE (BINARY)

DESCRIPTION: 1971 polygon file and 1983 polygon files; universal transverse mercator co-ordinate strings defining zonal polygon networks; one record per polygon.

REFERENCE: Working Paper No. 11, July, 1984

DATA SET TWELVE

FILE: POLYREAD.GIM

FILE TYPE: FORTRAN PROGRAM

PURPOSE: To convert binary polygon files into GIMMS-compatible input strings; the user must edit the output file and manually append a slash (/) at the end of each polygon string.

DATA SET THIRTEEN

FILES: G71.BASE
MAP5

FILE TYPE: COMMAND FILES

DESCRIPTION: Command files for the production of a GIMMS basefile (G71.BASE) and a GIMMS plot (MAP5).

REFERENCES: Working Paper No. 11,
Richer, S., "GIMMS Users Guide", Department of Geography, Carleton University, Ottawa, Ontario, October, 1978.

DATA SET FOURTEEN

FILES: BFILE71
BFILE81

FILE TYPE: DATA FILES

DESCRIPTION: Basemap information for GIMMS software;

locational data files.

PURPOSE: To provide a geographic reference for statistical mapping.

REFERENCE: Richer, S., "GIMMS Users Guide", Department of Geography, Carleton University, Ottawa, Ontario, October, 1978.

DATA SET FIFTEEN

FILES:
GD1
GD2
GD3

FILE TYPE: DATA FILES

DESCRIPTION: Examples of GIMMS input data, prepared from free format files contained in data set eight. This set contains 1981 data as follows:

GD1 - 1981 mode split to C.B.D., central and university destinations

GD2 - Employee density, bus stop density and average household income

GD3 - Scheduled transit travel time to downtown and university destinations.

DATA SET SIXTEEN

FILES:
PL5.71.CBD
PL5.71.CENT
PL5.71.U
PL10.71.EMPD
PL5.76.CBD
PL5.76.CENT
PL5.76.U
PL10.76.EMPD
PL5.81.BSD
PL5.81.INC
PL5.81.CBD
PL5.81.CENT

PL10.71.CBD
PL10.71.CENT
PL10.71.U
PL10.76.CBD
PL10.76.CENT
PL10.76.U
PL6.76.TTC
PL6.76.TTU
PL5.81.U
PL10.81.BSD
PL10.81.INC
PL10.81.EMPD
PL10.81.CBD
PL10.81.CENT
PL10.81.U
PL6.81.TTC
PL6.81.TTU

FILE TYPE: PLOT DESCRIPTION FILES

DESCRIPTION: Output from program GIMMS; plot description files suitable for use with the University of Alberta's Digital Plotting System.

ABBREVIATIONS:
BSD - BUS STOP DENSITY
CBD - CENTRAL BUSINESS DISTRICT (MODE SPLIT)
CENT - CENTRAL AREA (MODE SPLIT)
EMPD - EMPLOYEE DENSITY
TTC - TRANSIT TRAVEL TIME TO CENTRAL AREA
TTU - TRANSIT TRAVEL TIME TO UNIVERSITY AREA
U - UNIVERSITY (MODE SPLIT)

Table B1

File Listing for Tape 007533, Volume L17210

```
FILE              FILE NAME          VER# TYPE  LRECL  SIZE   DEV     DATE AND TIME SAVED    LEN(FT) USERID

   1   INDEX                            1 LINE     68     4   PAGE  NOV. 29, 1984. 09:50:14      2    301F
   2   EXTRACT76                        1 LINE     57     1   PAGE  NOV. 29, 1984. 09:50:30      4    301F
   3   EXTRACT81                        1 LINE     66     1   PAGE  NOV. 29, 1984. 09:50:41      5    301F
   4   ACCUM                            1 LINE     64     1   PAGE  NOV. 29, 1984. 09:50:54      6    301F
   5   ACCUM76                          1 LINE     68     1   PAGE  NOV. 29, 1984. 09:51:06      7    301F
   6   ACCUM81                          1 LINE     68     1   PAGE  NOV. 29, 1984. 09:51:15      8    301F
   7   EMPOP71                          1 LINE     65     3   PAGE  NOV. 29, 1984. 09:51:28      9    301F
   8   EMPOP76                          1 LINE     62     3   PAGE  NOV. 29, 1984. 09:51:35     11    301F
   9   EMPOP81TRAF                      1 LINE     54     3   PAGE  NOV. 29, 1984. 09:51:47     12    301F
  10   TT71TRAF                         1 LINE    104     3   PAGE  NOV. 29, 1984. 09:52:01     13    301F
  11   TT76TRAF                         1 LINE     66     2   PAGE  NOV. 29, 1984. 09:52:08     14    301F
  12   TT81TRAF                         1 LINE     58     1   PAGE  NOV. 29, 1984. 09:52:18     15    301F
  13   TT71DATA                         1 LINE  12520   186   PAGE  NOV. 29, 1984. 10:05:29     27    301F
  14   TT76DATA                         1 LINE   1484   544   PAGE  NOV. 29, 1984. 10:08:21     58    301F
  15   TT71NE                           1 LINE     65     6   PAGE  NOV. 29, 1984. 10:08:37     60    301F
  16   TT71W                            1 LINE     62     6   PAGE  NOV. 29, 1984. 10:08:45     61    301F
  17   TT71SW                           1 LINE     62     5   PAGE  NOV. 29, 1984. 10:08:54     62    301F
  18   TT76NE                           1 LINE     62     6   PAGE  NOV. 29, 1984. 10:09:01     64    301F
  19   TT76W                            1 LINE     62     6   PAGE  NOV. 29, 1984. 10:09:10     65    301F
  20   TT76SW                           1 LINE     62     4   PAGE  NOV. 29, 1984. 10:09:19     67    301F
  21   TT81NE                           1 LINE     60     4   PAGE  NOV. 29, 1984. 10:09:30     68    301F
  22   TT81W                            1 LINE     60     4   PAGE  NOV. 29, 1984. 10:09:37     69    301F
  23   TT81SW                           1 LINE     60     3   PAGE  NOV. 29, 1984. 10:09:47     70    301F
  24   TTP71NE                          1 LINE     74     6   PAGE  NOV. 29, 1984. 10:10:02     72    301F
  25   TTP71W                           1 LINE     74     6   PAGE  NOV. 29, 1984. 10:10:14     73    301F
  26   TTP71SW                          1 LINE     74     5   PAGE  NOV. 29, 1984. 10:10:25     75    301F
  27   TTP76NE                          1 LINE     67     6   PAGE  NOV. 29, 1984. 10:10:37     76    301F
  28   TTP76W                           1 LINE     66     6   PAGE  NOV. 29, 1984. 10:10:48     78    301F
  29   TTP76SW                          1 LINE     68     4   PAGE  NOV. 29, 1984. 10:11:10     79    301F
  30   TTP81NE                          1 LINE     61     4   PAGE  NOV. 29, 1984. 10:11:31     80    301F
  31   TTP81W                           1 LINE     61     4   PAGE  NOV. 29, 1984. 10:11:40     81    301F
  32   TTP81SW                          1 LINE     61     3   PAGE  NOV. 29, 1984. 10:11:48     83    301F
  33   ST71                             1 LINE     95     4   PAGE  NOV. 29, 1984. 10:11:55     84    301F
  34   ST76                             1 LINE     82     3   PAGE  NOV. 29, 1984. 10:12:03     85    301F
  35   ST81                             1 LINE     65     4   PAGE  NOV. 29, 1984. 10:12:11     87    301F
  36   DAT71                            1 LINE     76     8   PAGE  NOV. 29, 1984. 10:12:24     88    301F
  37   DAT81                            1 LINE     64     4   PAGE  NOV. 29, 1984. 10:12:38     89    301F
  38   VAR71                            1 LINE     68     7   PAGE  NOV. 29, 1984. 16:46:00     91    301F
  39   VAR76                            1 LINE     68     6   PAGE  NOV. 29, 1984. 16:46:07     92    301F
  40   VAR81                            1 LINE     65     7   PAGE  NOV. 29, 1984. 16:46:15     94    301F
  41   TRAFPOLYGON                      1 LINE    252    11   PAGE  NOV. 29, 1984. 16:46:40     95    301F
  42   POLY83.BI                        1 LINE    356    13   PAGE  NOV. 29, 1984. 16:46:57     97    301F
  43   POLYREAD.GIM                     1 LINE     61     1   PAGE  NOV. 29, 1984. 16:47:19     98    301F
  44   G71.BASE                         1 LINE     57    14   PAGE  NOV. 29, 1984. 16:47:38    100    301F
  45   MAPS                             1 LINE     65     1   PAGE  NOV. 29, 1984. 16:47:45    101    301F
  46   BFILE71                          1 LINE   1032    11   PAGE  NOV. 29, 1984. 16:48:03    103    301F
  47   BFILE81                          1 LINE   1032    13   PAGE  NOV. 29, 1984. 16:48:11    105    301F
  48   GD1                              1 LINE     32     6   PAGE  NOV. 29, 1984. 16:48:27    106    301F
  49   GD2                              1 LINE     32     5   PAGE  NOV. 29, 1984. 16:48:35    108    301F
  50   GD3                              1 LINE     24     4   PAGE  NOV. 29, 1984. 16:48:40    109    301F
  51   PL5.71.CBD                       1 LINE    254    20   PAGE  NOV. 30, 1984. 15:59:59    111    301F
  52   PL5.71.CENT                      1 LINE    254    21   PAGE  NOV. 30, 1984. 16:00:12    113    301F
  53   PL5.71.U                         1 LINE    254    19   PAGE  NOV. 30, 1984. 16:00:22    115    301F
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  56   PL10.71.CENT                     1 LINE    254    22   PAGE  NOV. 30, 1984. 16:01:01    122    301F
  57   PL10.71.U                        1 LINE    254    21   PAGE  NOV. 30, 1984. 16:01:12    124    301F
  58   PL5.76.CBD                       1 LINE    254    20   PAGE  NOV. 30, 1984. 16:01:32    127    301F
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  60   PL5.76.U                         1 LINE    254    22   PAGE  NOV. 30, 1984. 16:02:02    131    301F
  61   PL10.76.EMPD                     1 LINE    254    20   PAGE  DEC. 01, 1984. 12:35:33    133    301F
  62   PL10.76.CBD                      1 LINE    254    21   PAGE  DEC. 01, 1984. 12:35:51    136    301F
  63   PL10.76.CENT                     1 LINE    254    23   PAGE  DEC. 01, 1984. 12:36:06    138    301F
  64   PL10.76.U                        1 LINE    254    22   PAGE  DEC. 01, 1984. 12:36:15    140    301F
  65   PL5.76.TTC                       1 LINE    254    23   PAGE  DEC. 01, 1984. 12:36:36    143    301F
  66   PL5.76.TTU                       1 LINE    254    27   PAGE  DEC. 01, 1984. 12:36:49    145    301F
  67   PL5.81.BSD                       1 LINE    254    18   PAGE  DEC. 01, 1984. 12:37:07    147    301F
  68   PL5.81.INC                       1 LINE    254    29   PAGE  DEC. 01, 1984. 12:37:18    150    301F
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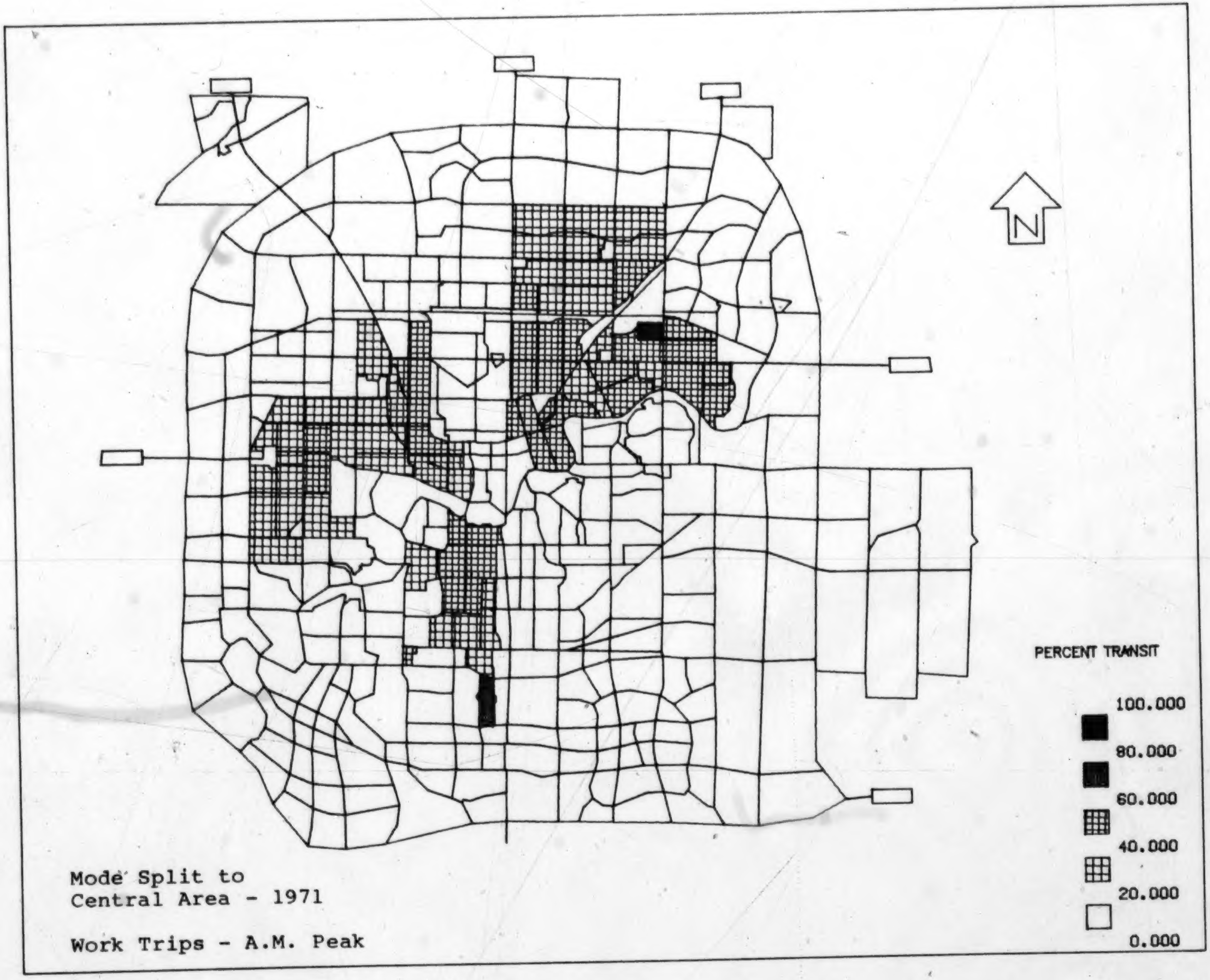
  70   PL5.81.CENT                      1 LINE    254    28   PAGE  DEC. 01, 1984. 12:37:38    155    301F
  71   PL5.81.U                         1 LINE    254    26   PAGE  DEC. 01, 1984. 12:51:24    157    301F
  72   PL10.81.BSD                      1 LINE    254    22   PAGE  DEC. 01, 1984. 12:51:38    160    301F
  73   PL10.81.INC                      1 LINE    254    28   PAGE  DEC. 01, 1984. 12:51:48    162    301F
  74   PL10.81.EMPD                     1 LINE    254    23   PAGE  DEC. 01, 1984. 12:51:59    165    301F
  75   PL10.81.CBD                      1 LINE    254    25   PAGE  DEC. 01, 1984. 12:52:21    167    301F
  76   PL10.81.CENT                     1 LINE    254    27   PAGE  DEC. 01, 1984. 12:52:30    170    301F
  77   PL10.81.U                        1 LINE    254    28   PAGE  DEC. 01, 1984. 12:52:39    172    301F
  78   PL5.81.TTC                       1 LINE    254    26   PAGE  DEC. 01, 1984. 12:52:57    175    301F
  79   PL5.81.TTU                       1 LINE    254    27   PAGE  DEC. 01, 1984. 12:53:06    177    301F
```

APPENDIX C

CHOROPLETHIC MAPPING

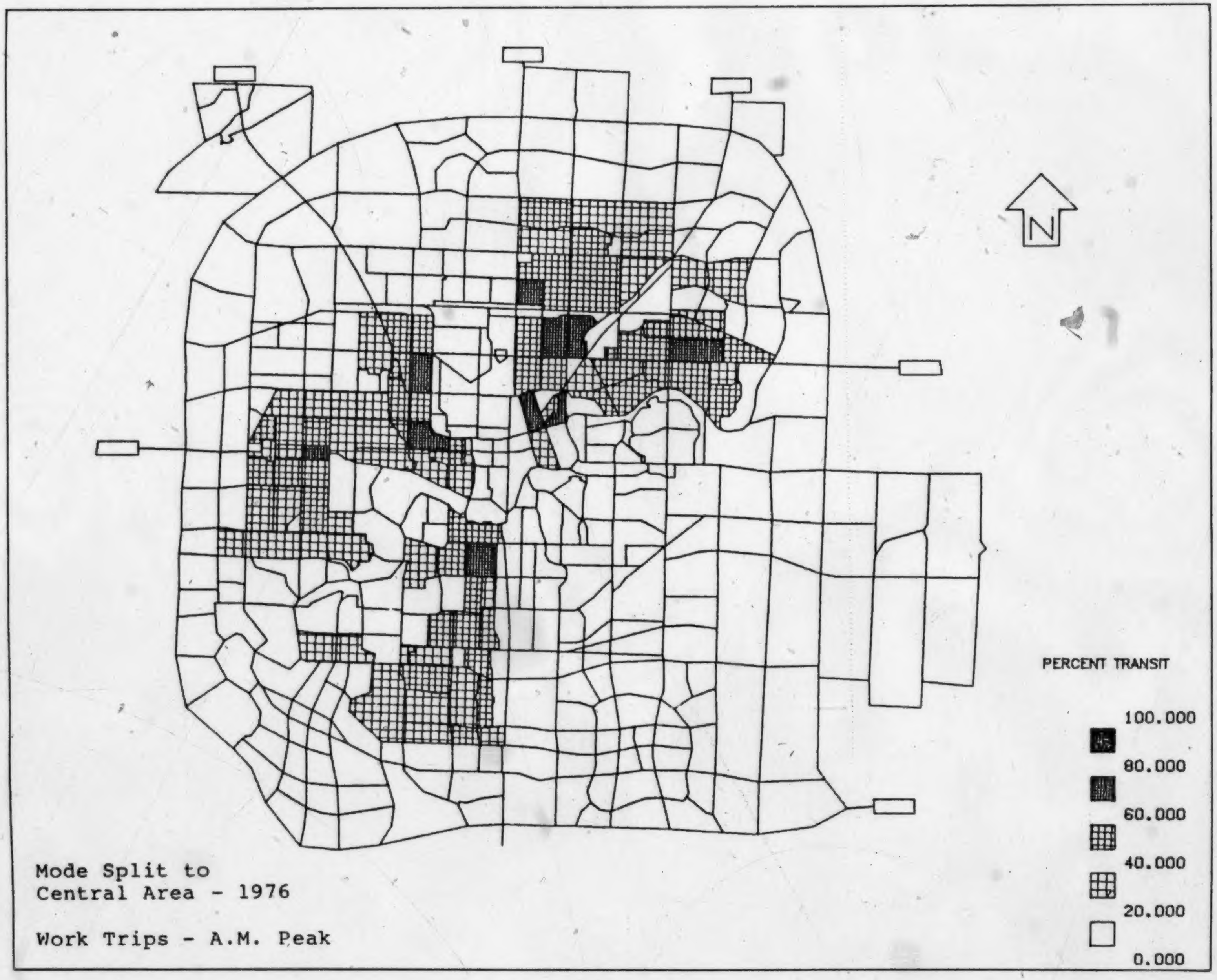
AN EXAMPLE OF A GIMMS COMMAND FILE

```
*SYSPARM DIAGS=3 NOLIST
*PLOTPARM CALCOMP
*PLOTPROC
*NEWMAP 50 50 FRAME
*GIMMSFILE 11 BFILE81
*DATMAN 442 1 1
*DATA STREAM 13 1 (24X,F8.2)
*DEFINE PCBD=1 *
*SET 1 (PCBD)
*END
*SCALE SIZE=40
*ORIGIN PLOT=1,1
*TEXT POSITION=2,7,SIZE=0.3,ALPHABET=15,' EDMONTON TRAFFIC ZONES'
*TEXT POSITION=2,4,SIZE=0.4,ALPHABET=15,'MODE SPLIT TO
UNIVERSITY AREA - 1981'
*TEXT POSITION=30,5,SIZE=0.25,ALPHABET=12,'DRAWN BY A. J. THERIAULT'
*NORTHPT POSITION=5.0,30.0,SIZE=3.0,NDRAW
*LEVELS 5
*INTERVALS EQUAL
*SYMBOLISM AREA 10.0,0,60,1/0.35,2,0,1+0.35,92,0,1/0.27,2,0,3+0.27,
92,0,3/0.12,2,0,2+0.12,92,0,2/0.05,2,0,1+0.05,92,0,1/
*LEGEND
*MAP 1
*END
*STOP
```


N
PERCENT TRANSIT
■ 100.000
■ 80.000
▦ 60.000
⊞ 40.000
☐ 20.000
0.000

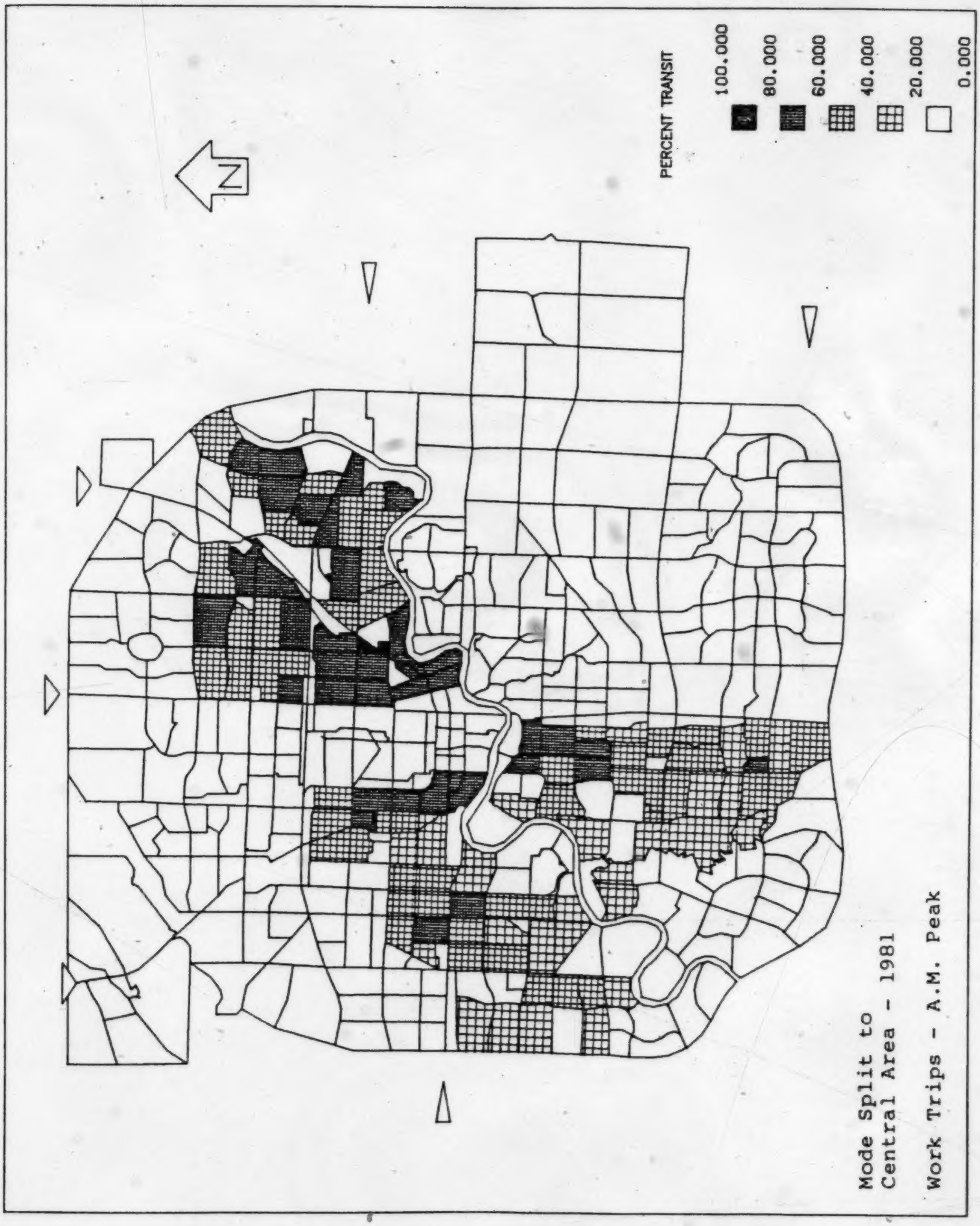
Mode Split to
Central Area - 1971

Work Trips - A.M. Peak


PERCENT TRANSIT
100.000
80.000
60.000
40.000
20.000
0.000
N

Mode Split to
Central Area - 1976

Work Trips - A.M. Peak



Mode Split to
Central Area - 1981

Work Trips - A.M. Peak

N
PERCENT TRANSIT
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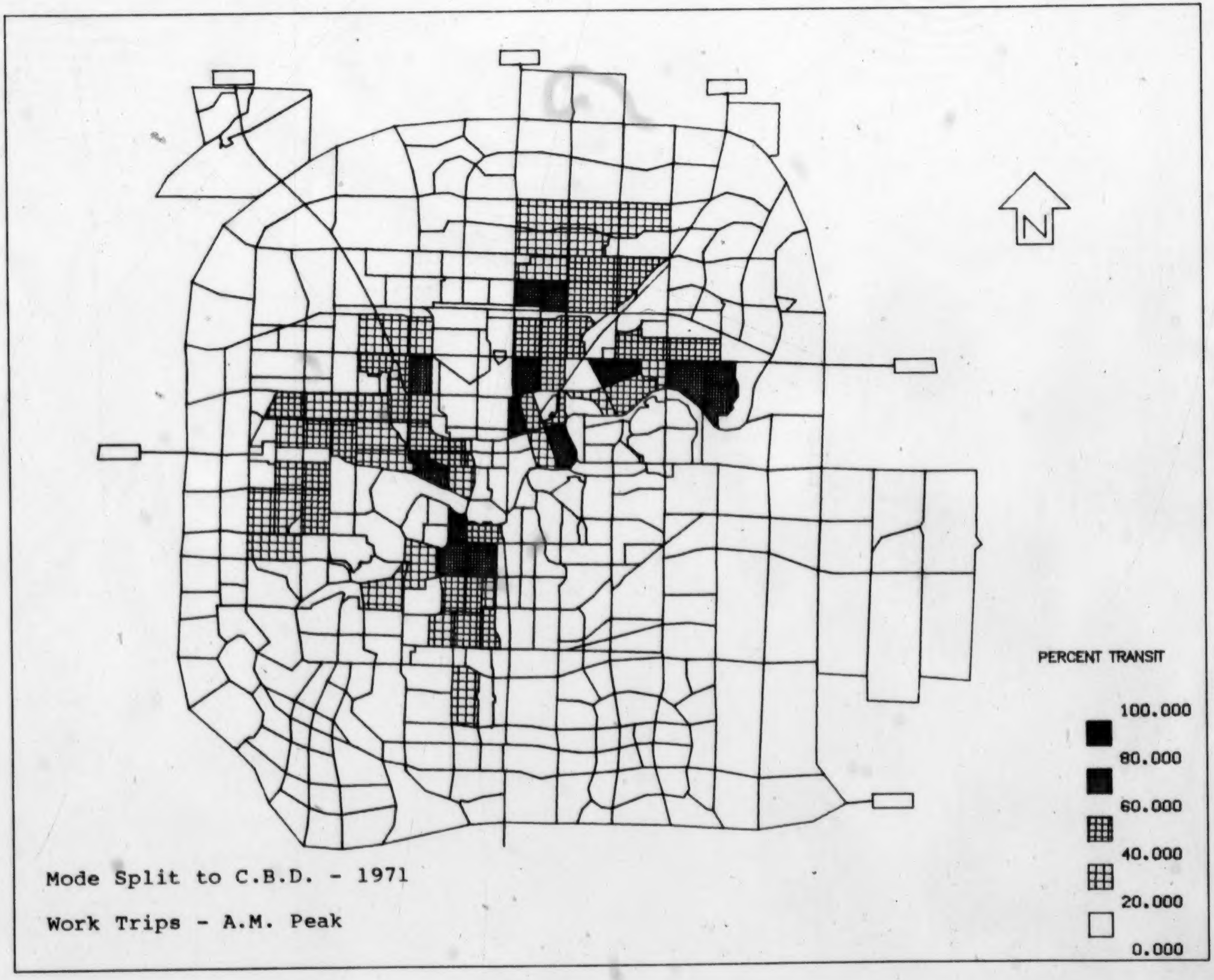
80.000
60.000
40.000
20.000
0.000


N
PERCENT TRANSIT
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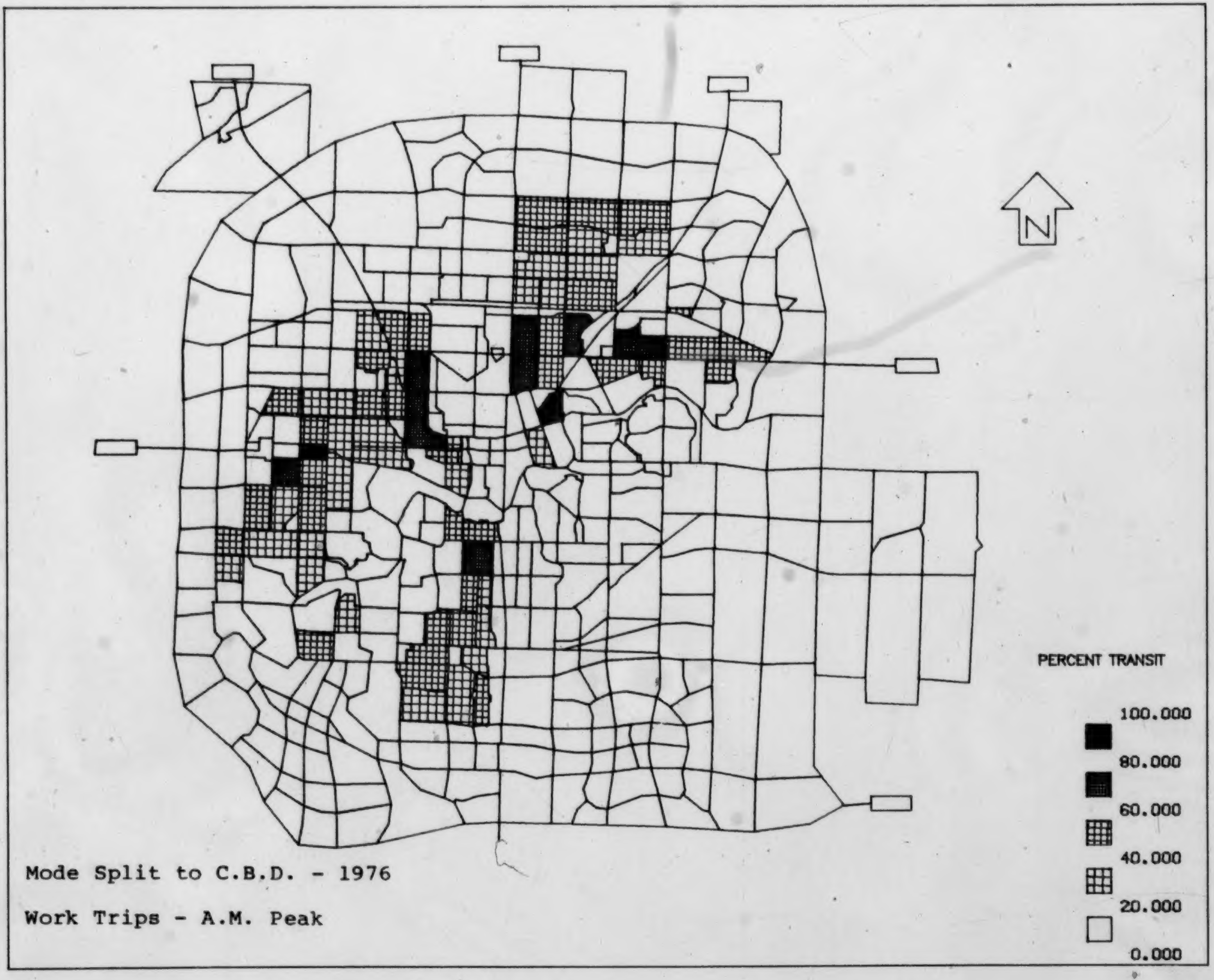
80.000
60.000
40.000
20.000
0.000

Mode Split to C.B.D. - 1971

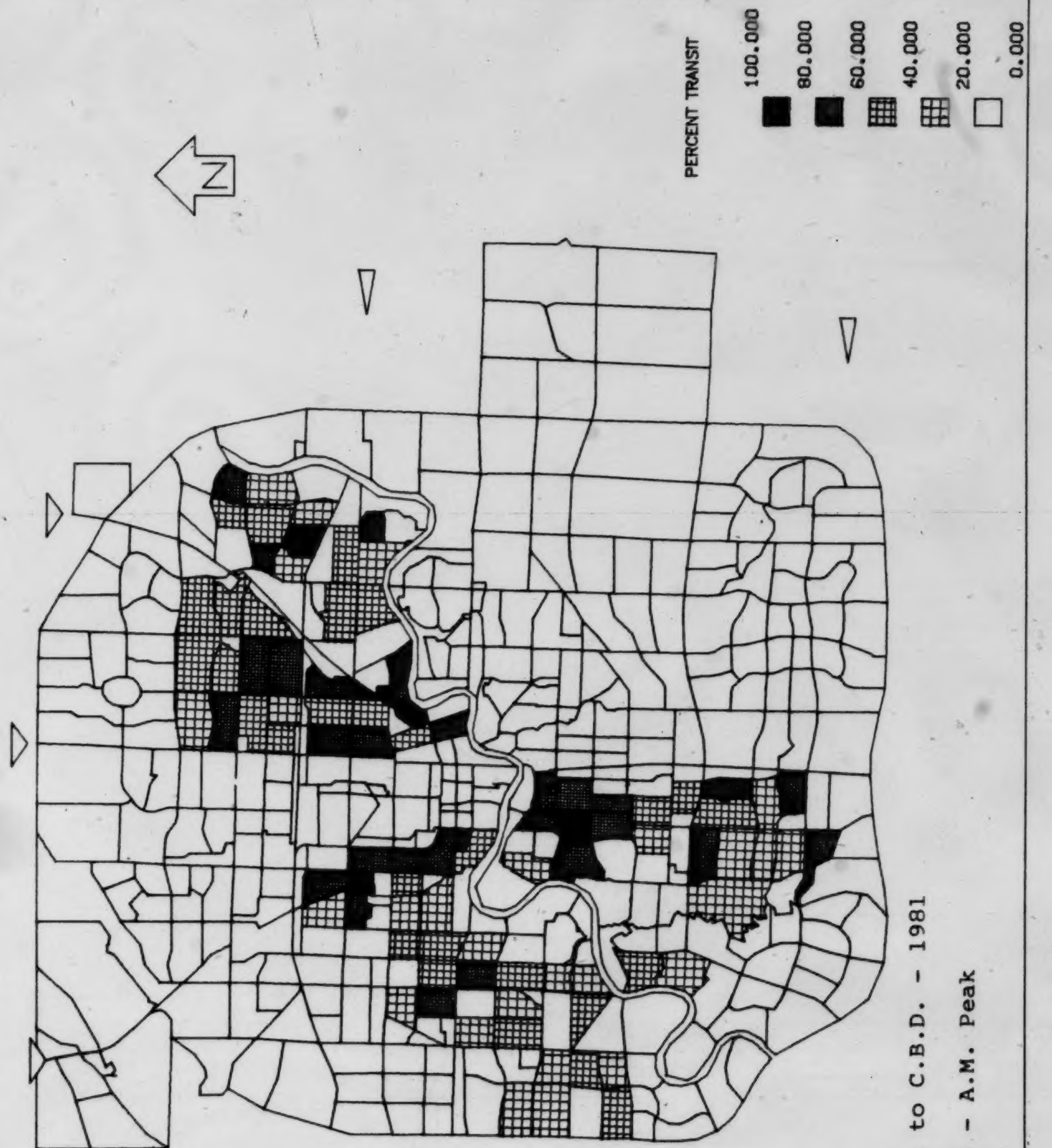
Work Trips - A.M. Peak



N
PERCENT TRANSIT
100.000
80.000
60.000
40.000
20.000
0.000

Mode Split to C.B.D. - 1976

Work Trips - A.M. Peak


N
PERCENT TRANSIT
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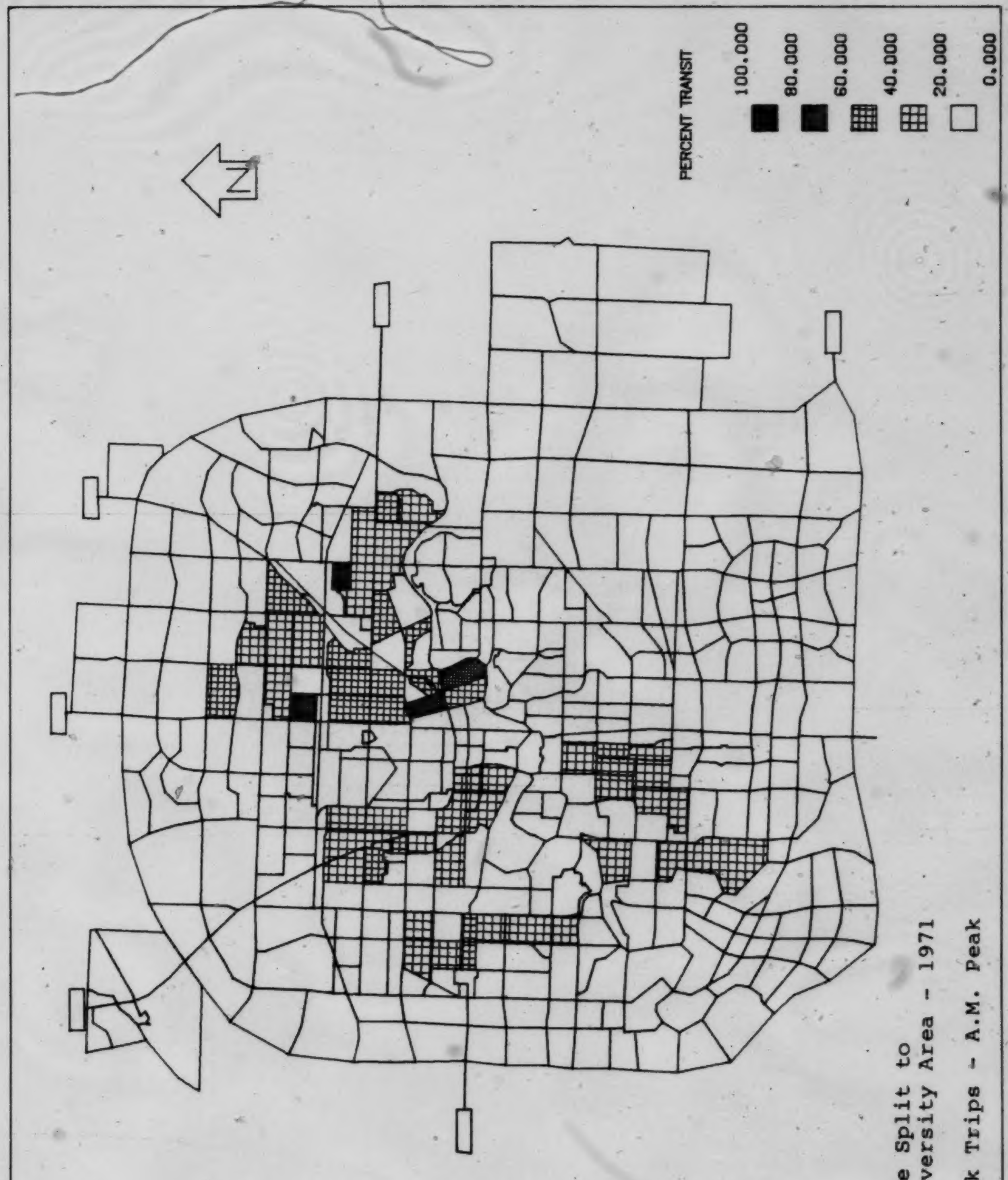
80.000
60.000
40.000
20.000
0.000

Mode Split to C.B.D. - 1981

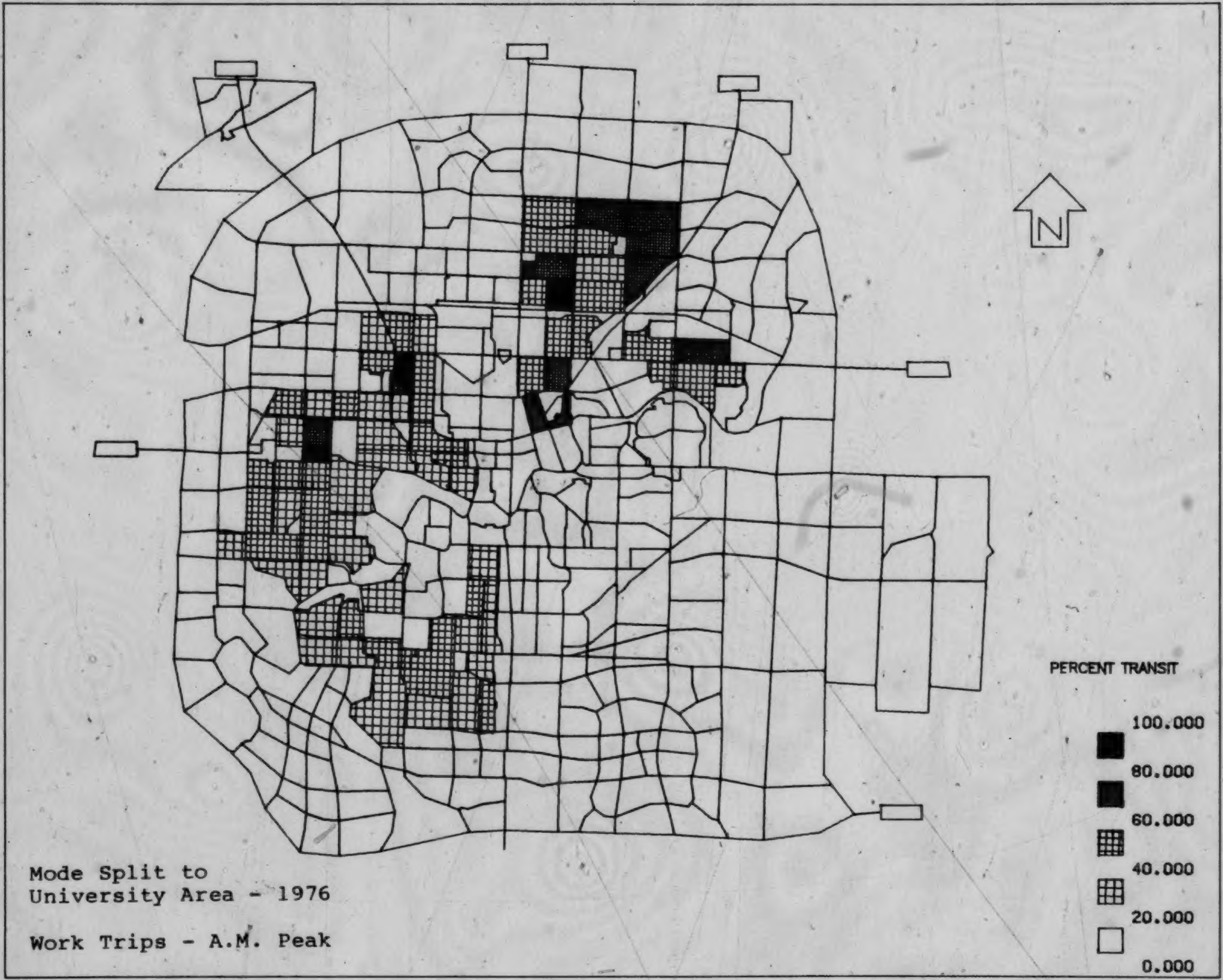
Work Trips - A.M. Peak



Mode Split to University Area - 1971

Work Trips - A.M. Peak

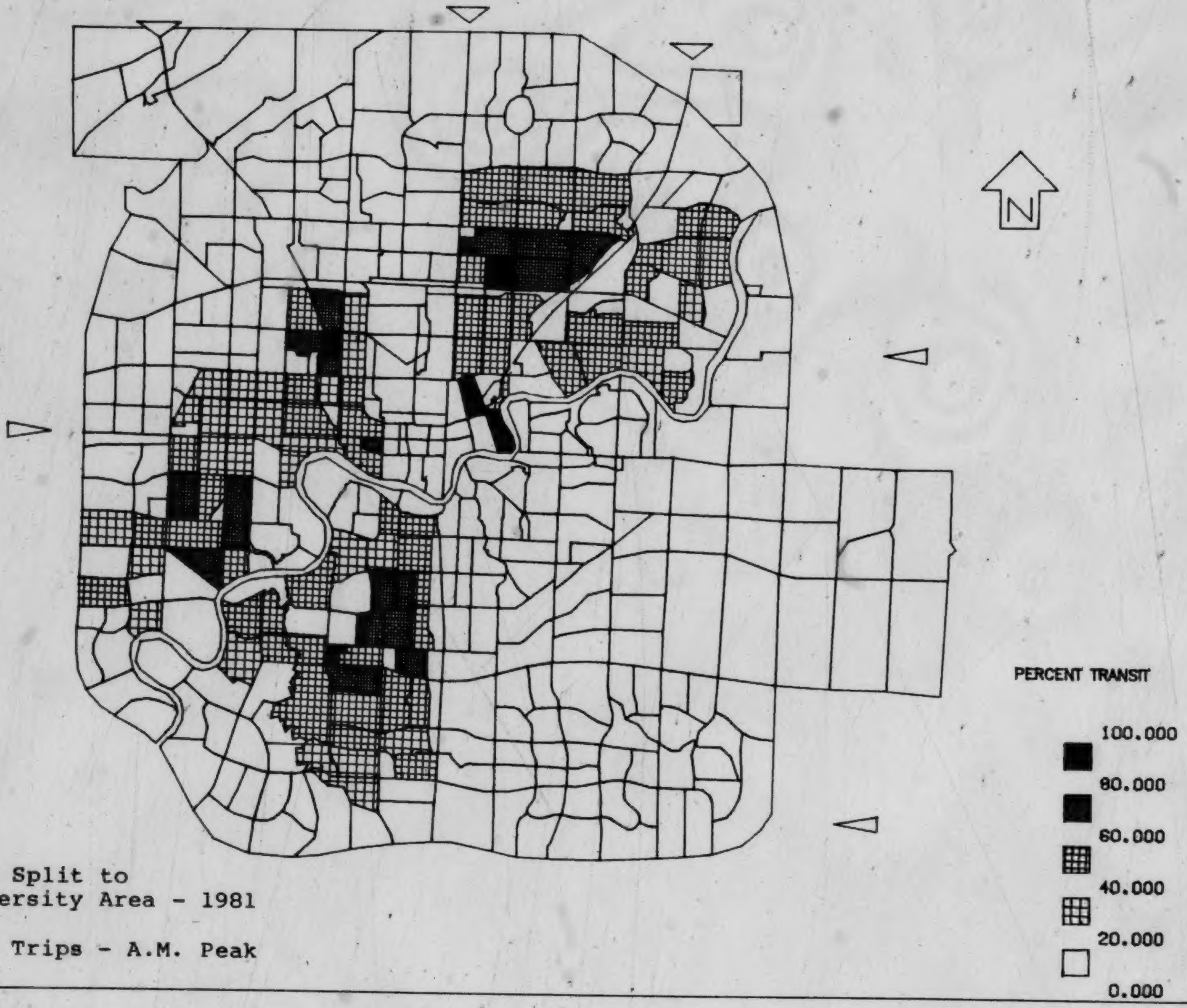
PERCENT TRANSIT
100.000
80.000
60.000
40.000
20.000
0.000
N



Mode Split to
University Area - 1976

Work Trips - A.M. Peak

N
PERCENT TRANSIT
100.000
80.000
60.000
40.000
20.000
0.000


N
PERCENT TRANSIT
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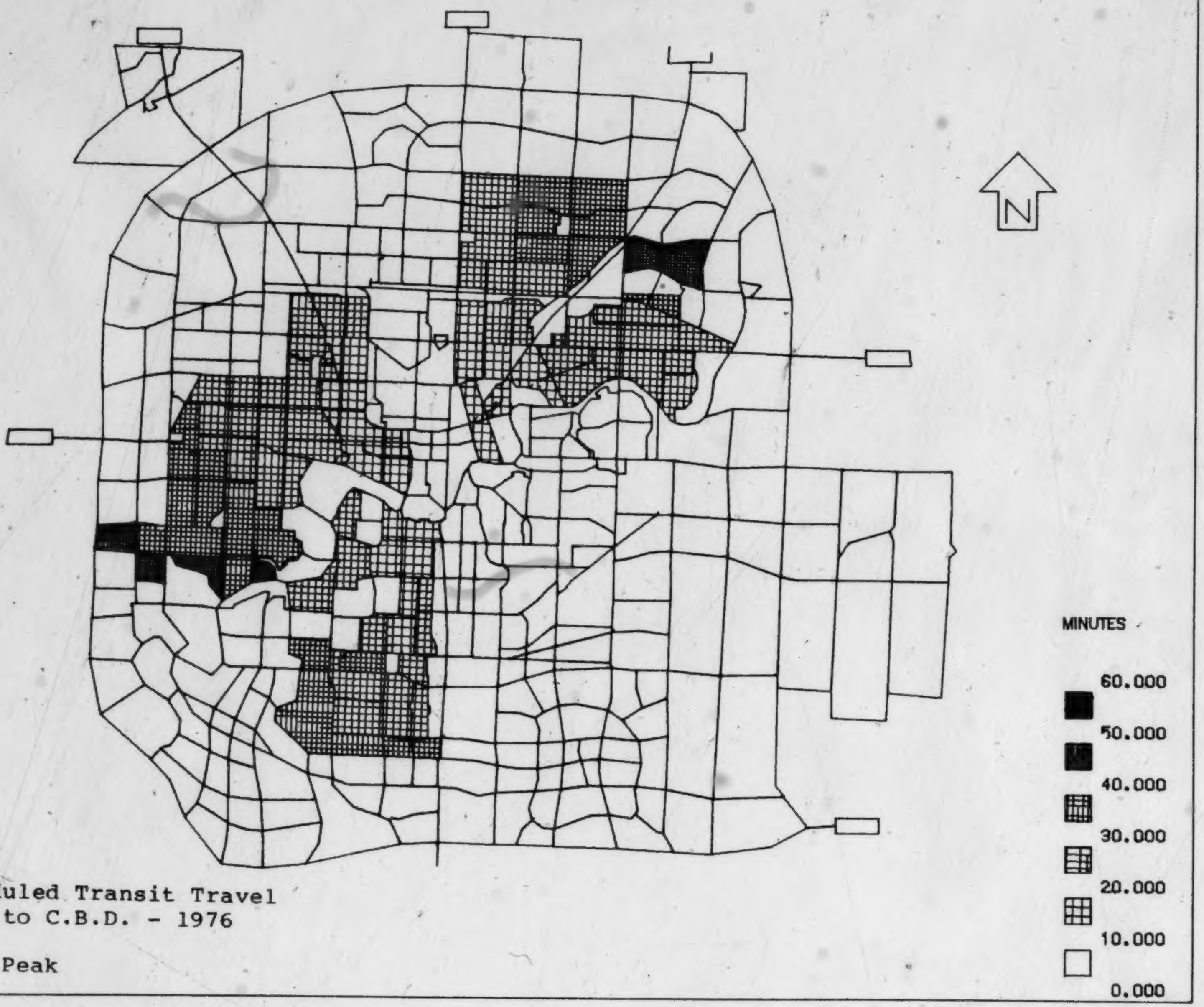
80.000
60.000
40.000
20.000
0.000

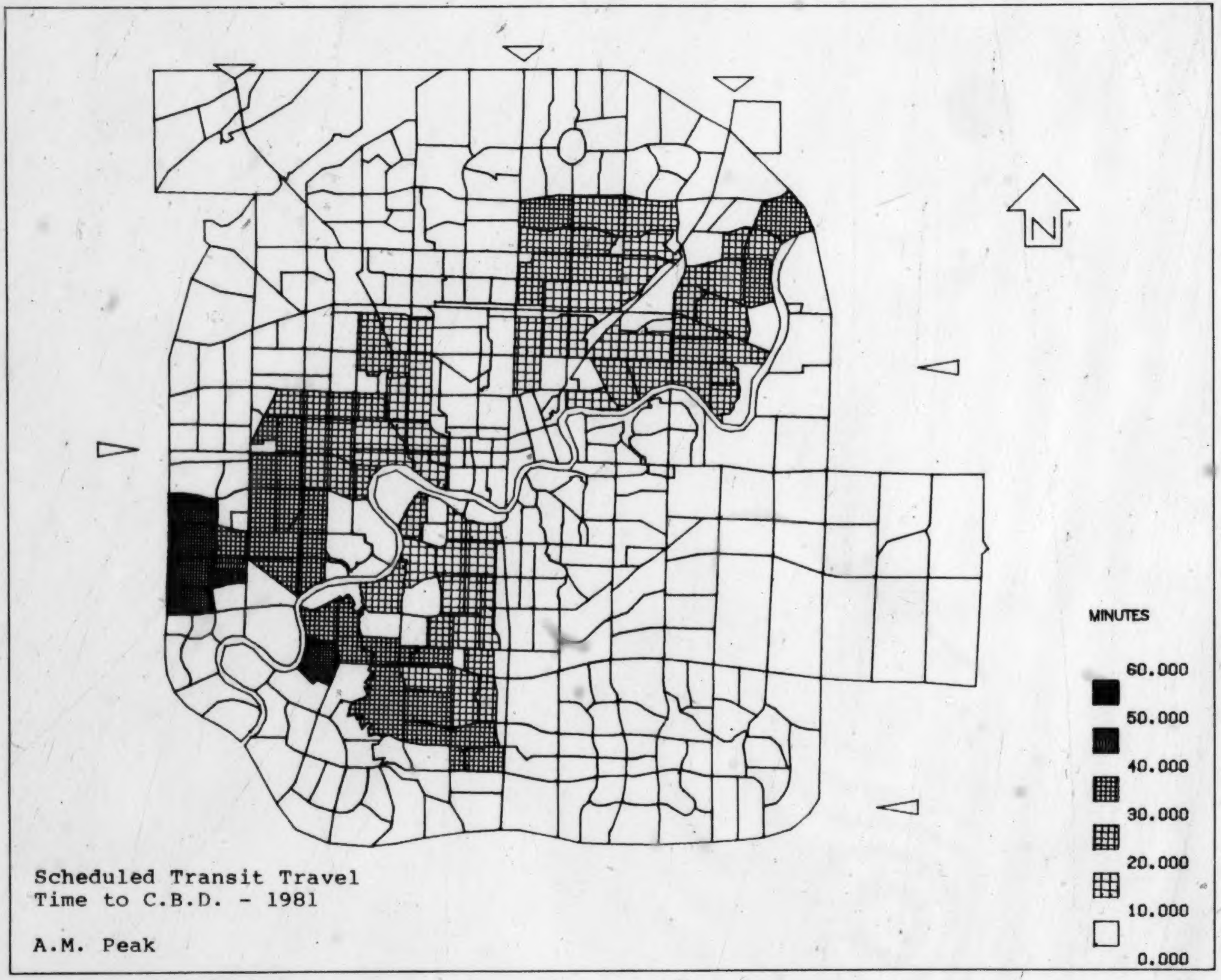
Mode Split to
University Area - 1981

Work Trips - A.M. Peak


N
MINUTES
60.000
50.000
40.000
30.000
20.000
10.000
0.000

Scheduled Transit Travel
Time to C.B.D. - 1976

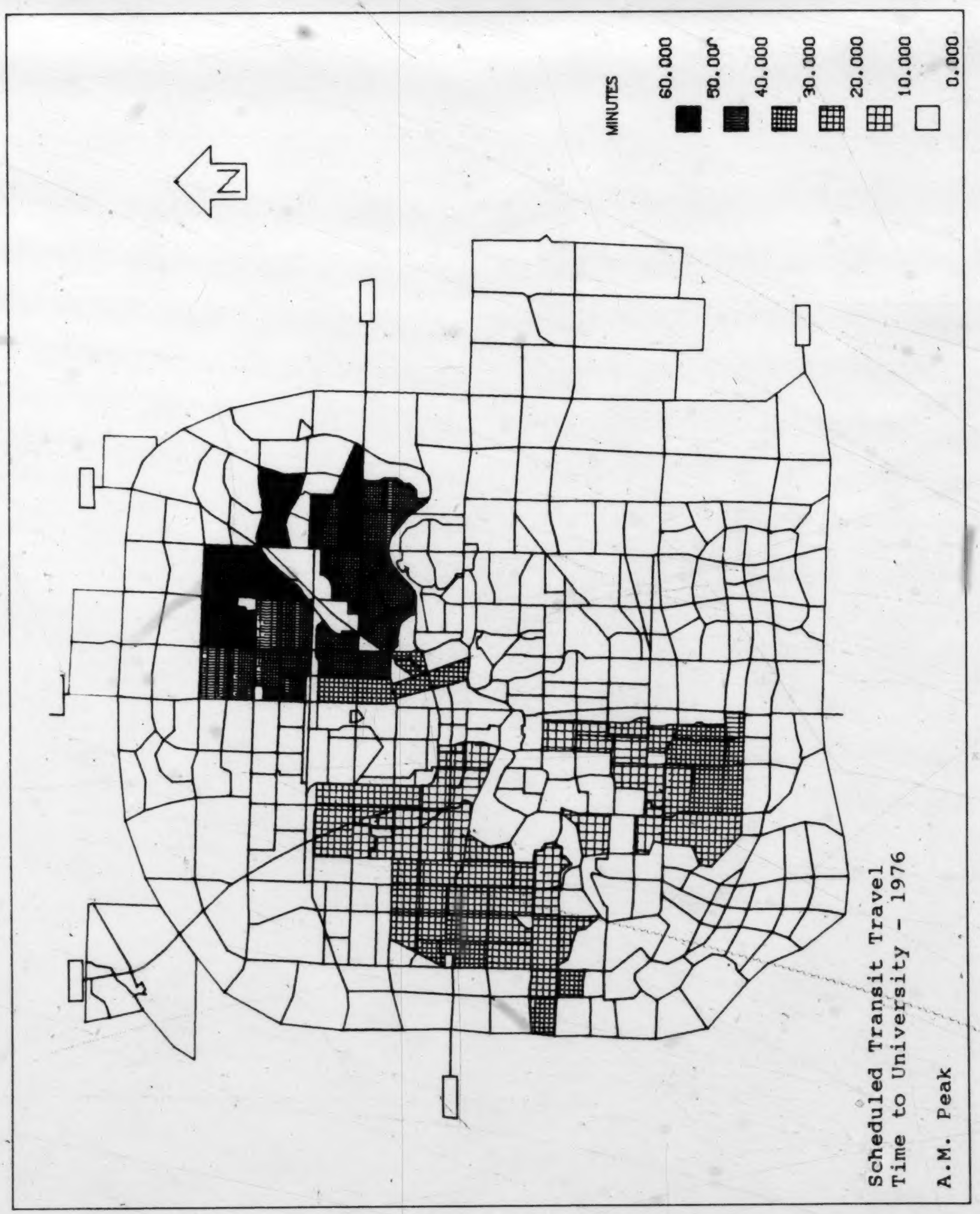
A.M. Peak



MINUTES
60.000
50.000
40.000
30.000
20.000
10.000
0.000
N

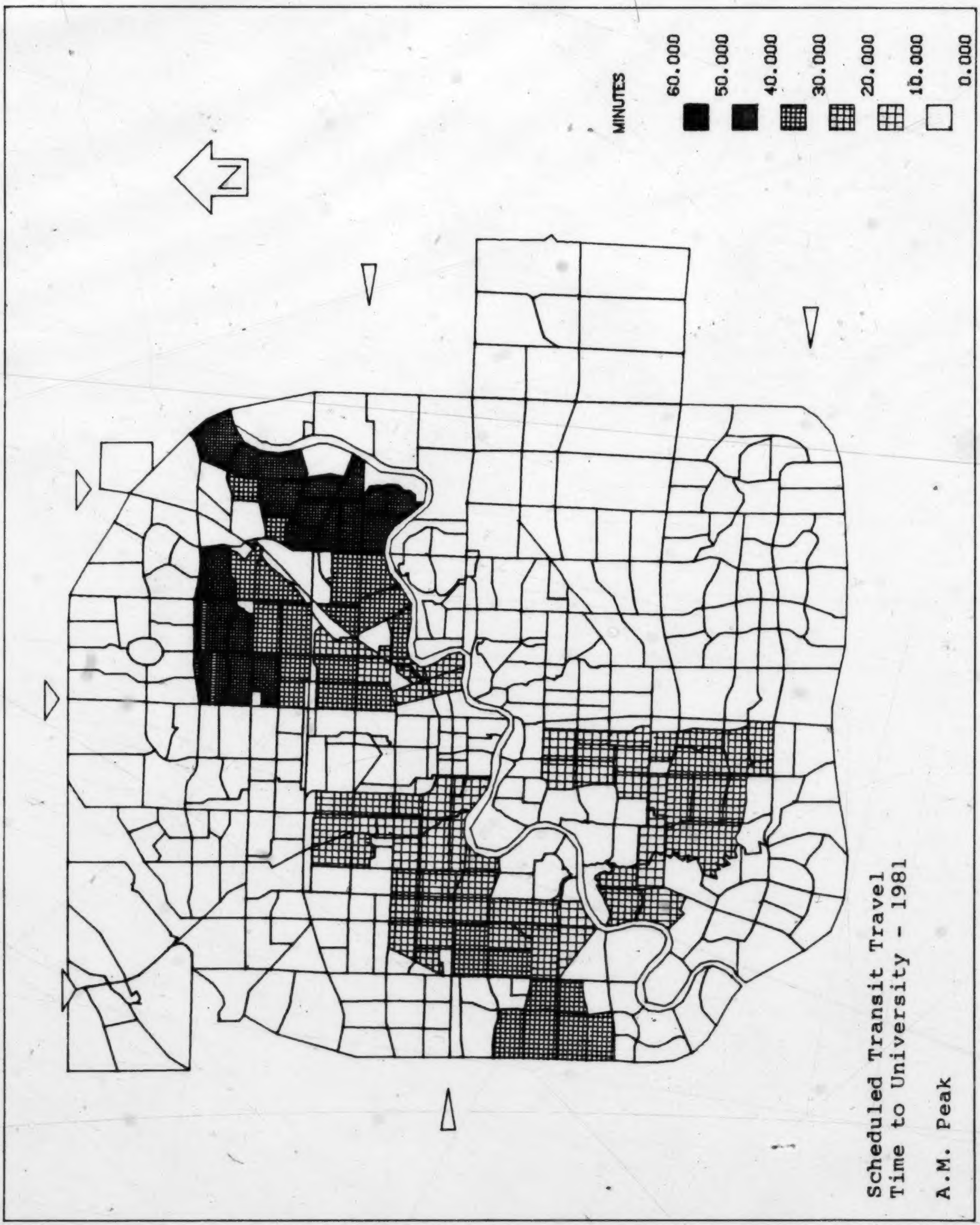
Scheduled Transit Travel
Time to C.B.D. - 1981

A.M. Peak


N
MINUTES
60.000
50.000
40.000
30.000
20.000
10.000
0.000

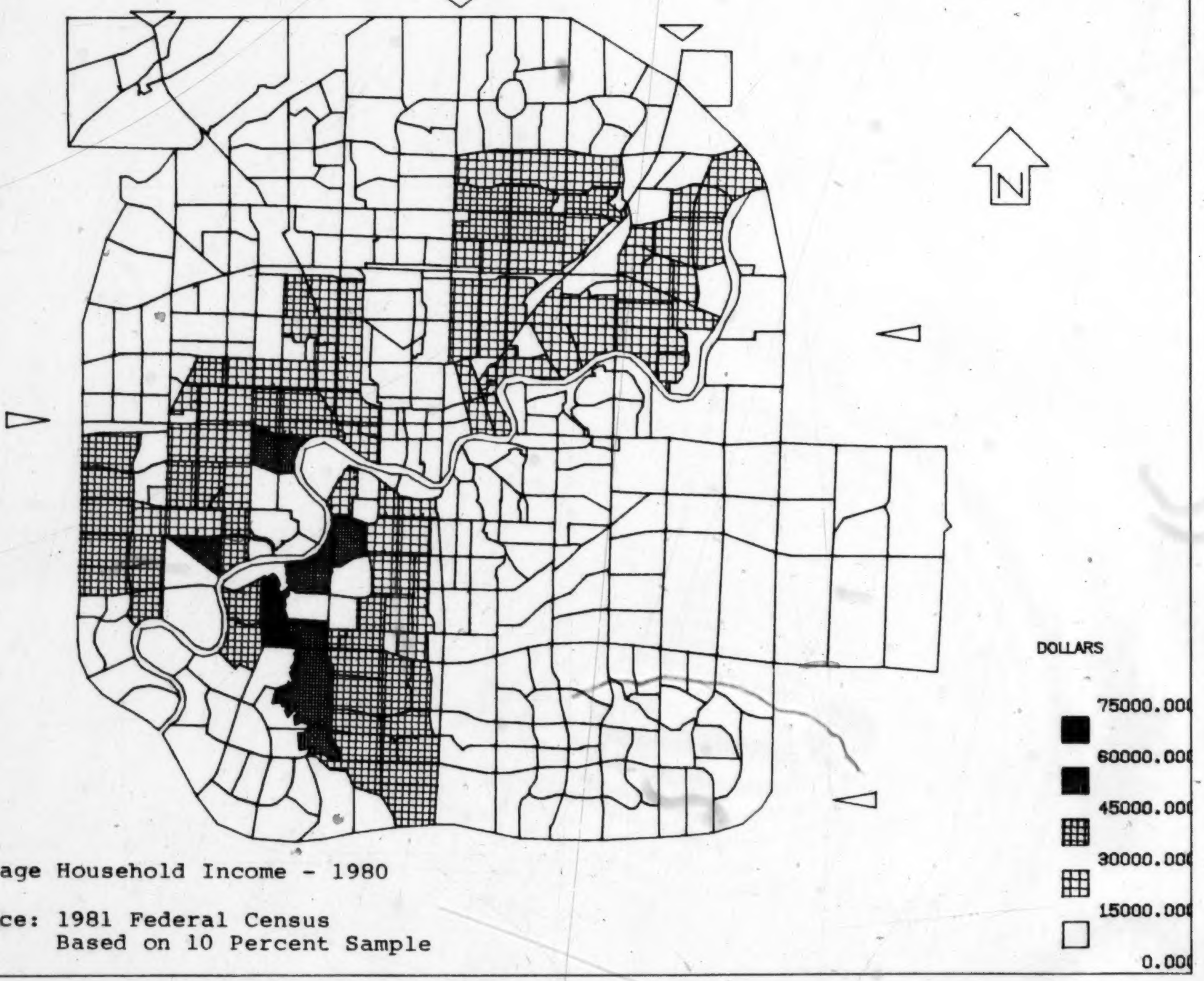
Scheduled Transit Travel
Time to University - 1976

A.M. Peak


N
MINUTES
60.000
50.000
40.000
30.000
20.000
10.000
0.000

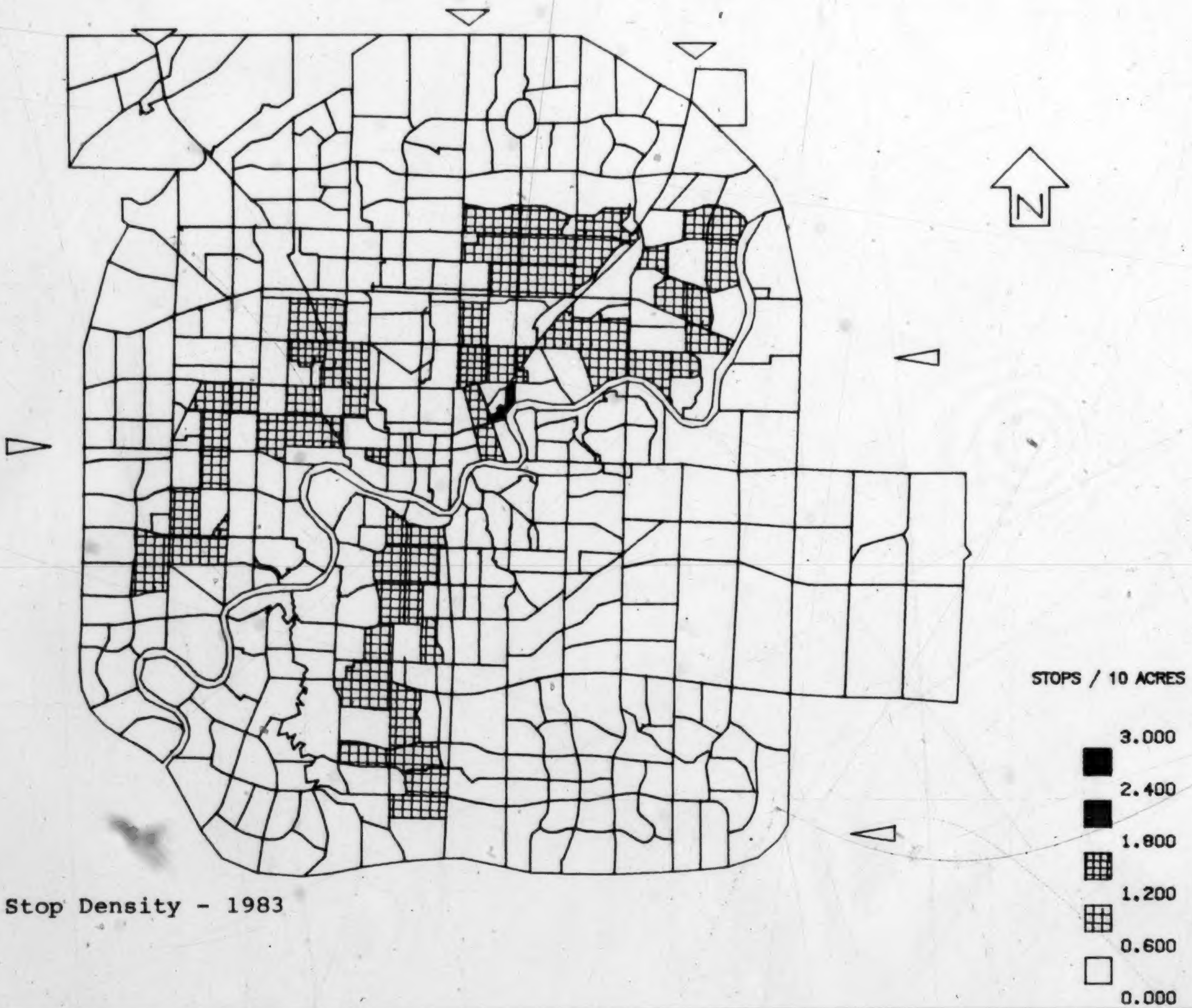
Scheduled Transit Travel
Time to University - 1981

A.M. Peak


N
DOLLARS
75000.00
60000.00
45000.00
30000.00
15000.00
0.00

Average Household Income - 1980

Source: 1981 Federal Census
Based on 10 Percent Sample


N
STOPS / 10 ACRES
3.000
2.400
1.800
1.200
0.600
0.000

Bus Stop Density - 1983

APPENDIX D

TIME SERIES TABLES

EXPLANATORY NOTES:

- Trip information refers to work and post-secondary school trips during morning peak conditions.
- "T.T./100 H.H." refers to "Transit Trips per Hundred Households".
- Employee density statistics are shown as persons per acre.
- Missing or statistically insignificant values are denoted by "-1.0".

```
ZONE    84.          1971          1976          1981
*********************************************************
POPULATION          4571.         4057.         3768.
EMPLOYEES           1484.         1622.         1806.
HOUSEHOLDS          1536.         1466.         1520.
ACREAGE              248.          247.          251.
%TRANSIT-CBD          57.           69.           75.
%TRANSIT-CENTRAL      48.           55.           67.
%TRANSIT-UNIV.        50.           -1.           41.
TRANSIT TRIPS-CBD.    24.           11.           15.
TRANSIT TRIPS-CENT.  107.           47.           73.
TRANSIT TRIPS-UNIV.   11.            5.            7.
T.T./100 H.H.-CBD.   1.56          0.75          0.99
T.T./100 H.H.-CENT.  6.97          3.21          4.80
T.T./100 H.H.-UNIV.  0.72          0.34          0.46
EMPLOYEE DENSITY     5.98          6.56          7.20
ZONE    85.          1971          1976          1981
*********************************************************
POPULATION          4342.         4019.         3991.
EMPLOYEES           1611.         1787.         2121.
HOUSEHOLDS          1466.         1489.         1657.
ACREAGE              251.          248.          256.
%TRANSIT-CBD          51.           45.           57.
%TRANSIT-CENTRAL      42.           61.           60.
%TRANSIT-UNIV.        42.           46.           57.
TRANSIT TRIPS-CBD.    24.           10.           20.
TRANSIT TRIPS-CENT.   81.           85.           82.
TRANSIT TRIPS-UNIV.   10.           16.           17.
T.T./100 H.H.-CBD.   1.64          0.67          1.21
T.T./100 H.H.-CENT.  5.53          5.71          4.95
T.T./100 H.H.-UNIV.  0.68          1.07          1.03
EMPLOYEE DENSITY     6.43          7.22          8.29
```

```
ZONE   86.          1971           1976          1981
********************************************************
POPULATION          3459.          3116.         2679.
EMPLOYEES           1310.          1433.         1452.
HOUSEHOLDS          1052.          1109.         1101.
ACREAGE              218.           215.          223.
%TRANSIT-CBD          44.            62.           73.
%TRANSIT-CENTRAL      48.            62.           72.
%TRANSIT-UNIV.        44.            44.           57.
TRANSIT TRIPS-CBD.    16.            13.           11.
TRANSIT TRIPS-CENT.   78.            78.           70.
TRANSIT TRIPS-UNIV.    7.            12.            8.
T.T./100 H.H.-CBD.   1.52           1.17          1.00
T.T./100 H.H.-CENT.  7.41           7.03          6.36
T.T./100 H.H.-UNIV.  0.67           1.08          0.73
EMPLOYEE DENSITY     6.02           6.66          6.50
ZONE   91.          1971           1976          1981
********************************************************
POPULATION          5484.          4849.         4307.
EMPLOYEES           1695.          1891.         1937.
HOUSEHOLDS          1884.          1748.         1786.
ACREAGE              232.           229.          231.
%TRANSIT-CBD          67.            61.           75.
%TRANSIT-CENTRAL      56.            58.           66.
%TRANSIT-UNIV.        42.            57.           53.
TRANSIT TRIPS-CBD.    43.            23.            6.
TRANSIT TRIPS-CENT.  116.            95.           92.
TRANSIT TRIPS-UNIV.   16.            16.           19.
T.T./100 H.H.-CBD.   2.28           1.32          0.34
T.T./100 H.H.-CENT.  6.16           5.43          5.15
T.T./100 H.H.-UNIV.  0.85           0.92          1.06
EMPLOYEE DENSITY     7.31           8.24          8.39
```

```
ZONE    92.           1971          1976          1981
**********************************************************
POPULATION            4429.         3907.         3280.
EMPLOYEES             1377.         1606.         1654.
HOUSEHOLDS            1377.         1324.         1325.
ACREAGE                204.          203.          203.
%TRANSIT-CBD            57.           50.           57.
%TRANSIT-CENTRAL        54.           58.           65.
%TRANSIT-UNIV.          40.           69.           40.
TRANSIT TRIPS-CBD.      25.           13.           17.
TRANSIT TRIPS-CENT.     95.           76.           99.
TRANSIT TRIPS-UNIV.      8.           22.            8.
T.T./100 H.H.-CBD.    1.82          0.98          1.28
T.T./100 H.H.-CENT.   6.90          5.74          7.47
T.T./100 H.H.-UNIV.   0.58          1.66          0.60
EMPLOYEE DENSITY      6.74          7.92          8.13
ZONE   101.           1971          1976          1981
**********************************************************
POPULATION            3664.         3140.         2898.
EMPLOYEES              876.         1166.         1359.
HOUSEHOLDS             994.         1100.         1277.
ACREAGE                149.          148.          148.
%TRANSIT-CBD            48.           -1.           59.
%TRANSIT-CENTRAL        50.           73.           64.
%TRANSIT-UNIV.          64.           65.           83.
TRANSIT TRIPS-CBD.      14.            6.           10.
TRANSIT TRIPS-CENT.     53.           41.           44.
TRANSIT TRIPS-UNIV.      9.           13.           15.
T.T./100 H.H.-CBD.    1.41          0.55          0.78
T.T./100 H.H.-CENT.   5.33          3.73          3.45
T.T./100 H.H.-UNIV.   0.91          1.18          1.17
EMPLOYEE DENSITY      5.87          7.87          9.18
```

```
ZONE   103.            1971            1976             1981
***************************************************************
POPULATION             413.            480.             715.
EMPLOYEES              181.            242.             393.
HOUSEHOLDS             152.            198.             280.
ACREAGE                 64.             62.              60.
%TRANSIT-CBD            -1.             78.              83.
%TRANSIT-CENTRAL        51.             59.              79.
%TRANSIT-UNIV.          58.             -1.              -1.
TRANSIT TRIPS-CBD.       4.              7.               5.
TRANSIT TRIPS-CENT.     18.             24.              27.
TRANSIT TRIPS-UNIV.      7.              3.               2.
T.T./100 H.H.-CBD.    2.63            3.54             1.79
T.T./100 H.H.-CENT.  11.84           12.12             9.64
T.T./100 H.H.-UNIV.   4.61            1.52             0.71
EMPLOYEE DENSITY      2.84            3.88             6.59
ZONE   104.            1971            1976             1981
***************************************************************
POPULATION            2271.           2436.            2315.
EMPLOYEES             1183.           1454.            1590.
HOUSEHOLDS             958.           1171.            1247.
ACREAGE                 92.             70.              72.
%TRANSIT-CBD            50.             72.              94.
%TRANSIT-CENTRAL        57.             70.              76.
%TRANSIT-UNIV.          57.             61.              53.
TRANSIT TRIPS-CBD.      29.             26.              15.
TRANSIT TRIPS-CENT.    163.            168.             135.
TRANSIT TRIPS-UNIV.     17.             27.               8.
T.T./100 H.H.-CBD.    3.03            2.22             1.20
T.T./100 H.H.-CENT.  17.01           14.35            10.83
T.T./100 H.H.-UNIV.   1.77            2.31             0.64
EMPLOYEE DENSITY     12.80           20.80            21.98
```

```
ZONE   105.            1971            1976            1981
************************************************************
POPULATION            2915.           1968.           2321.
EMPLOYEES              886.            642.           1013.
HOUSEHOLDS            1277.            788.           1382.
ACREAGE                190.            146.            155.
%TRANSIT-CBD            34.             31.             75.
%TRANSIT-CENTRAL        40.             33.             73.
%TRANSIT-UNIV.          55.             -1.             -1.
TRANSIT TRIPS-CBD.      11.              5.              9.
TRANSIT TRIPS-CENT.     51.             16.             40.
TRANSIT TRIPS-UNIV.     21.              4.              4.
T.T./100 H.H.-CBD.    0.86            0.63            0.65
T.T./100 H.H.-CENT.   3.99            2.03            2.89
T.T./100 H.H.-UNIV.   1.64            0.51            0.29
EMPLOYEE DENSITY      4.66            4.40            6.53
ZONE   126.            1971            1976            1981
************************************************************
POPULATION            5401.           4651.           4796.
EMPLOYEES             1736.           1974.           2294.
HOUSEHOLDS            1527.           1542.           1802.
ACREAGE                322.            318.            373.
%TRANSIT-CBD            54.             64.             50.
%TRANSIT-CENTRAL        42.             46.             60.
%TRANSIT-UNIV.          32.             41.             50.
TRANSIT TRIPS-CBD.      26.             14.             13.
TRANSIT TRIPS-CENT.     91.             77.            100.
TRANSIT TRIPS-UNIV.     14.              9.             11.
T.T./100 H.H.-CBD.    1.70            0.91            0.72
T.T./100 H.H.-CENT.   5.96            4.99            5.55
T.T./100 H.H.-UNIV.   0.92            0.58            0.61
EMPLOYEE DENSITY      5.39            6.20            6.15
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ZONE    131.             1971            1976            1981
**************************************************************
POPULATION               973.            870.            713.
EMPLOYEES                284.            340.            344.
HOUSEHOLDS               229.            235.            224.
ACREAGE                  220.            218.            211.
%TRANSIT-CBD              -1.             -1.             -1.
%TRANSIT-CENTRAL          42.             52.             74.
%TRANSIT-UNIV.            -1.             -1.             -1.
TRANSIT TRIPS-CBD.         2.              1.              2.
TRANSIT TRIPS-CENT.       10.             15.             14.
TRANSIT TRIPS-UNIV.        1.              2.              3.
T.T./100 H.H.-CBD.       0.87            0.43            0.89
T.T./100 H.H.-CENT.      4.37            6.38            6.25
T.T./100 H.H.-UNIV.      0.44            0.85            1.34
EMPLOYEE DENSITY         1.29            1.56            1.63
ZONE    132.             1971            1976            1981
**************************************************************
POPULATION              4815.           4295.           3999.
EMPLOYEES               1524.           1783.           1924.
HOUSEHOLDS              1261.           1267.           1369.
ACREAGE                  296.            294.            293.
%TRANSIT-CBD              57.             48.             54.
%TRANSIT-CENTRAL          47.             62.             58.
%TRANSIT-UNIV.            31.             60.             57.
TRANSIT TRIPS-CBD.        26.             10.             13.
TRANSIT TRIPS-CENT.       99.             95.             69.
TRANSIT TRIPS-UNIV.       10.              9.             12.
T.T./100 H.H.-CBD.       2.06            0.79            0.95
T.T./100 H.H.-CENT.      7.85            7.50            5.04
T.T./100 H.H.-UNIV.      0.79            0.71            0.88
EMPLOYEE DENSITY         5.15            6.07            6.57
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ZONE   134.              1971          1976           1981
*******************************************************************
POPULATION               3456.         1227.          2487.
EMPLOYEES                1161.          520.          1330.
HOUSEHOLDS                927           360.           892.
ACREAGE                   359.          302.           279.
%TRANSIT-CBD               64.           -1.            33.
%TRANSIT-CENTRAL           46.           42.            46.
%TRANSIT-UNIV.             33.           50.            35.
TRANSIT TRIPS-CBD.         14.            4.             3.
TRANSIT TRIPS-CENT.        76.           19.            42.
TRANSIT TRIPS-UNIV.        10.            6.             6.
T.T./100 H.H.-CBD.       1.51          1.11           0.34
T.T./100 H.H.-CENT.      8.20          5.28           4.71
T.T./100 H.H.-UNIV.      1.08          1.67           0.67
EMPLOYEE DENSITY         3.23          1.72           4.77
ZONE   135.              1971          1976           1981
*******************************************************************
POPULATION               1487.         2946.          3158.
EMPLOYEES                 418.         1036.          1493.
HOUSEHOLDS                357.          824.           990.
ACREAGE                   160.          161.           138.
%TRANSIT-CBD               60.           58.            78.
%TRANSIT-CENTRAL           47.           39.            54.
%TRANSIT-UNIV.             53.           55.            -1.
TRANSIT TRIPS-CBD.         12.            7.             7.
TRANSIT TRIPS-CENT.        29.           43.            35.
TRANSIT TRIPS-UNIV.         8.            6.             3.
T.T./100 H.H.-CBD.       3.36          0.85           0.71
T.T./100 H.H.-CENT.      8.12          5.22           3.54
T.T./100 H.H.-UNIV.      2.24          0.73           0.30
EMPLOYEE DENSITY         2.61          6.43          10.82
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ZONE   137.            1971            1976            1981
*************************************************************
POPULATION            2573.            988.           2394.
EMPLOYEES              826.            388.           1193.
HOUSEHOLDS             641.            265.            713.
ACREAGE                252.            232.            188.
%TRANSIT-CBD            69.             -1.             -1.
%TRANSIT-CENTRAL        41.             55.             60.
%TRANSIT-UNIV.          33.             -1.             42.
TRANSIT TRIPS-CBD.       9.              3.              4.
TRANSIT TRIPS-CENT.     56.             27.             46.
TRANSIT TRIPS-UNIV.      6.              4.              5.
T.T./100 H.H.-CBD.     1.40            1.13            0.56
T.T./100 H.H.-CENT.    8.74           10.19            6.45
T.T./100 H.H.-UNIV.    0.94            1.51            0.70
EMPLOYEE DENSITY       3.28            1.67            6.34
ZONE   191.            1971            1976            1981
*************************************************************
POPULATION            2959.           3753.           5124.
EMPLOYEES              975.           1486.           2374.
HOUSEHOLDS             711.            939.           1505.
ACREAGE                385.            370.            422.
%TRANSIT-CBD            23.             43.             51.
%TRANSIT-CENTRAL        20.             30.             58.
%TRANSIT-UNIV.          13.             62.             56.
TRANSIT TRIPS-CBD.       5.              6.             20.
TRANSIT TRIPS-CENT.     36.             36.            119.
TRANSIT TRIPS-UNIV.      3.             16.             19.
T.T./100 H.H.-CBD.     0.70            0.64            1.33
T.T./100 H.H.-CENT.    5.06            3.83            7.91
T.T./100 H.H.-UNIV.    0.42            1.70            1.26
EMPLOYEE DENSITY       2.53            4.02            5.63
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ZONE   192.            1971            1976            1981
***********************************************************
POPULATION             4757.           7598.           5141.
EMPLOYEES              1443.           2888.           2466.
HOUSEHOLDS             1088.           1886.           1536.
ACREAGE                 293.            306.            284.
%TRANSIT-CBD             15.             25.             44.
%TRANSIT-CENTRAL         26.             35.             60.
%TRANSIT-UNIV.            5.             73.             53.
TRANSIT TRIPS-CBD.        6.             10.             15.
TRANSIT TRIPS-CENT.      47.             98.            122.
TRANSIT TRIPS-UNIV.       1.             19.             18.
T.T./100 H.H.-CBD.      0.55            0.53            0.98
T.T./100 H.H.-CENT.     4.32            5.20            7.94
T.T./100 H.H.-UNIV.     0.09            1.01            1.17
EMPLOYEE DENSITY        4.92            9.43            8.67
ZONE   201.            1971            1976            1981
***********************************************************
POPULATION             4954.           4746.           4168.
EMPLOYEES              1480.           1725.           1830.
HOUSEHOLDS             1331.           1471.           1336.
ACREAGE                 320.            315.            313.
%TRANSIT-CBD             59.             13.             59.
%TRANSIT-CENTRAL         43.             24.             66.
%TRANSIT-UNIV.           54.             70.             79.
TRANSIT TRIPS-CBD.       19.              1.             13.
TRANSIT TRIPS-CENT.      80.             29.             74.
TRANSIT TRIPS-UNIV.       7.              7.             23.
T.T./100 H.H.-CBD.      1.43            0.07            0.97
T.T./100 H.H.-CENT.     6.01            1.97            5.54
T.T./100 H.H.-UNIV.     0.53            0.48            1.72
EMPLOYEE DENSITY        4.62            5.47            5.84
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ZONE   211.               1971           1976           1981
*****************************************************************
POPULATION               5863.          6673.          4797.
EMPLOYEES                1816.          2588.          2473.
HOUSEHOLDS               1340.          1640.          1364.
ACREAGE                   317.           315.           342.
%TRANSIT-CBD               42.            30.            70.
%TRANSIT-CENTRAL           34.            42.            56.
%TRANSIT-UNIV.             32.            33.            60.
TRANSIT TRIPS-CBD.         26.            11.            14.
TRANSIT TRIPS-CENT.        84.            71.            97.
TRANSIT TRIPS-UNIV.        11.            10.            41.
T.T./100 H.H.-CBD.       1.94           0.67           1.03
T.T./100 H.H.-CENT.      6.27           4.33           7.11
T.T./100 H.H.-UNIV.      0.82           0.61           3.01
EMPLOYEE DENSITY         5.73           8.21           7.24
ZONE   212.               1971           1976           1981
*****************************************************************
POPULATION               5672.          6446.          4735.
EMPLOYEES                1812.          2578.          2363.
HOUSEHOLDS               1458.          1857.          1589.
ACREAGE                   377.           375.           376.
%TRANSIT-CBD               40.            48.            68.
%TRANSIT-CENTRAL           29.            49.            62.
%TRANSIT-UNIV.             29.            56.            71.
TRANSIT TRIPS-CBD.         14.            14.            13.
TRANSIT TRIPS-CENT.        63.           101.            97.
TRANSIT TRIPS-UNIV.         6.             9.            17.
T.T./100 H.H.-CBD.       0.96           0.75           0.82
T.T./100 H.H.-CENT.      4.32           5.44           6.10
T.T./100 H.H.-UNIV.      0,41           0.48           1.07
EMPLOYEE DENSITY         4.80           6.87           6.28
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ZONE   221.               1971            1976            1981
***************************************************************
POPULATION               5204.           6025.           5350.
EMPLOYEES                1749.           2500.           2586.
HOUSEHOLDS               1315.           1755.           1694.
ACREAGE                   369.            365.            445.
%TRANSIT-CBD               36.             52.             42.
%TRANSIT-CENTRAL           23.             39.             62.
%TRANSIT-UNIV.             13.             62.             48.
TRANSIT TRIPS-CBD.         17.             22.             11.
TRANSIT TRIPS-CENT.        57.            112.            117.
TRANSIT TRIPS-UNIV.         4.             13.             15.
T.T./100 H.H.-CBD.       1.29            1.25            0.65
T.T./100 H.H.-CENT.      4.33            6.38            6.91
T.T./100 H.H.-UNIV.      0.30            0.74            0.89
EMPLOYEE DENSITY         4.74            6.84            5.81
ZONE   222.               1971            1976            1981
***************************************************************
POPULATION               3688.           3550.           3152.
EMPLOYEES                1175.           1450.           1601.
HOUSEHOLDS                920.            953.            957.
ACREAGE                   249.            258.            248.
%TRANSIT-CBD               31.             32.             59.
%TRANSIT-CENTRAL           22.             45.             55.
%TRANSIT-UNIV.             23.             42.             48.
TRANSIT TRIPS-CBD.         10.              6.             10.
TRANSIT TRIPS-CENT.        37.             67.             77.
TRANSIT TRIPS-UNIV.         9.              8.             11.
T.T./100 H.H.-CBD.       1.09            0.63            1.04
T.T./100 H.H.-CENT.      4.02            7.03            8.05
T.T./100 H.H.-UNIV.      0.98            0.84            1.15
EMPLOYEE DENSITY         4.72            5.63            6.45
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ZONE   261.              1971            1976            1981
****************************************************************
POPULATION              1876.           7730.           6529.

EMPLOYEES                603.           3051.           2887.

HOUSEHOLDS               456.           2192.           2007.

ACREAGE                  368.            364.            396.

%TRANSIT-CBD              35.             49.             26.

%TRANSIT-CENTRAL          35.             47.             43.

%TRANSIT-UNIV.            50.             45.             53.

TRANSIT TRIPS-CBD.         6.             22.              9.

TRANSIT TRIPS-CENT.       36.            128.            108.

TRANSIT TRIPS-UNIV.        9.              9.             16.

T.T./100 H.H.-CBD.      1.32            1.00            0.45

T.T./100 H.H.-CENT.     7.89            5.84            5.38

T.T./100 H.H.-UNIV.     1.97            0.41            0.80

EMPLOYEE DENSITY        1.64            8.38            7.29

ZONE   262.              1971            1976            1981
****************************************************************
POPULATION              2582.           4953.           3918.

EMPLOYEES                885.           1978.           1676.

HOUSEHOLDS               653.           1304.           1095.

ACREAGE                  324.            321.            301.

%TRANSIT-CBD              29.             54.             70.

%TRANSIT-CENTRAL          24.             35.             45.

%TRANSIT-UNIV.            13.             45.             47.

TRANSIT TRIPS-CBD.         9.             14.              7.

TRANSIT TRIPS-CENT.       30.             65.             55.

TRANSIT TRIPS-UNIV.        3.             29.             17.

T.T./100 H.H.-CBD.      1.38            1.07            0.64

T.T./100 H.H.-CENT.     4.59            4.98            5.02

T.T./100 H.H.-UNIV.     0.46            2.22            1.55

EMPLOYEE DENSITY        2.73            6.17            5.56
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ZONE   272.           1971          1976          1981
*********************************************************
POPULATION            4937.         5671.         3812.

EMPLOYEES             1682.         2463.         2013.

HOUSEHOLDS            1225.         1512.         1216.

ACREAGE                289.          287.          302.

%TRANSIT-CBD            38.           39.           56.

%TRANSIT-CENTRAL        31.           44.           52.

%TRANSIT-UNIV.          28.           71.           61.

TRANSIT TRIPS-CBD.      15.           12.           14.

TRANSIT TRIPS-CENT.     74.           85.           97.

TRANSIT TRIPS-UNIV.     11.           24.           33.

T.T./100 H.H.-CBD.     1.22          0.79          1.15

T.T./100 H.H.-CENT.    6.04          5.62          7.98

T.T./100 H.H.-UNIV.    0.90          1.59          2.71

EMPLOYEE DENSITY       5.82          8.57          6.67
ZONE   273.           1971          1976          1981
*********************************************************
POPULATION            2404.         2081.         1823.

EMPLOYEES              889.         1037.         1062.

HOUSEHOLDS             741.          728.          732.

ACREAGE                164.          163.          161.

%TRANSIT-CBD            66.           36.           59.

%TRANSIT-CENTRAL        54.           61.           63.

%TRANSIT-UNIV.          70.           58.           44.

TRANSIT TRIPS-CBD.      21.            4.           10.

TRANSIT TRIPS-CENT.     78.           34.           44.

TRANSIT TRIPS-UNIV.      7.            7.            4.

T.T./100 H.H.-CBD.     2.83          0.55          1.37

T.T./100 H.H.-CENT.   10.53          4.67          6.01

T.T./100 H.H.-UNIV.    0.94          0.96          0.55

EMPLOYEE DENSITY       5.43          6.36          6.60
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ZONE   274.             1971            1976            1981
***********************************************************
POPULATION             3834.           4970.           2916.
EMPLOYEES              1275.           2055.           1507.
HOUSEHOLDS             1048.           1415.           1038.
ACREAGE                 191.            190.            193.
%TRANSIT-CBD             62.             32.             27.
%TRANSIT-CENTRAL         37.             45.             58.
%TRANSIT-UNIV.           18.             81.             80.
TRANSIT TRIPS-CBD.       24.              7.              6.
TRANSIT TRIPS-CENT.      81.             75.             79.
TRANSIT TRIPS-UNIV.       2.             25.             16.
T.T./100 H.H.-CBD.     2.29            0.49            0.58
T.T./100 H.H.-CENT.    7.73            5.30            7.61
T.T./100 H.H.-UNIV.    0.19            1.77            1.54
EMPLOYEE DENSITY       6.66           10.84            7.82
ZONE   411.             1971            1976            1981
***********************************************************
POPULATION             3534.           3067.           2578.
EMPLOYEES              1171.           1371.           1369.
HOUSEHOLDS              897.            887.            880.
ACREAGE                 249.            245.            251.
%TRANSIT-CBD             28.             38.             33.
%TRANSIT-CENTRAL         28.             37.             46.
%TRANSIT-UNIV.           35.             33.             47.
TRANSIT TRIPS-CBD.       11.             11.              5.
TRANSIT TRIPS-CENT.      54.             65.             43.
TRANSIT TRIPS-UNIV.      17.             13.             14.
T.T./100 H.H.-CBD.     1.23            1.24            0.57
T.T./100 H.H.-CENT.    6.02            7.33            4.89
T.T./100 H.H.-UNIV.    1.90            1.47            1.59
EMPLOYEE DENSITY       4.71            5.60            5.45
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ZONE   412.          1971          1976          1981
********************************************************
POPULATION          2888.          2456.          2130.
EMPLOYEES           1074.          1192.          1175.
HOUSEHOLDS           793.           786.           779.
ACREAGE              166.           164.           168.
%TRANSIT-CBD          43.            50.            72.
%TRANSIT-CENTRAL      33.            39.            56.
%TRANSIT-UNIV.        47.            51.            63.
TRANSIT TRIPS-CBD.    15.             8.            13.
TRANSIT TRIPS-CENT.   59.            39.            44.
TRANSIT TRIPS-UNIV.   27.            23.            27.
T.T./100 H.H.-CBD.   1.89           1.02           1.67
T.T./100 H.H.-CENT.  7.44           4.96           5.65
T.T./100 H.H.-UNIV.  3.40           2.93           3.47
EMPLOYEE DENSITY     6.48           7.26           7.01
ZONE   423.          1971          1976          1981
********************************************************
POPULATION          3997.          3613.          2955.
EMPLOYEES           1402.          1639.          1553.
HOUSEHOLDS          1085.          1114.          1064.
ACREAGE              234.           233.           241.
%TRANSIT-CBD          31.            50.            60.
%TRANSIT-CENTRAL      18.            44.            55.
%TRANSIT-UNIV.        21.            46.            69.
TRANSIT TRIPS-CBD.     9.            13.            12.
TRANSIT TRIPS-CENT.   37.            69.            69.
TRANSIT TRIPS-UNIV.    8.            18.            25.
T.T./100 H.H.-CBD.   0.83           1.17           1.13
T.T./100 H.H.-CENT.  3.41           6.19           6.48
T.T./100 H.H.-UNIV.  0.74           1.62           2.35
EMPLOYEE DENSITY     5.98           7.04           6.45
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ZONE   424.             1971           1976           1981
********************************************************
POPULATION             2088.          1816.          1521.
EMPLOYEES               679.           815.           840.
HOUSEHOLDS              599.           599.           580.
ACREAGE                 201.           190.           197.
%TRANSIT-CBD             35.            55.            -1.
%TRANSIT-CENTRAL         41.            45.            53.
%TRANSIT-UNIV.           33.            33.            32.
TRANSIT TRIPS-CBD.        6.             6.             3.
TRANSIT TRIPS-CENT.      29.            31.            27.
TRANSIT TRIPS-UNIV.       5.             6.             6.
T.T./100 H.H.-CBD.     1.00           1.00           0.52
T.T./100 H.H.-CENT.    4.84           5.18           4.66
T.T./100 H.H.-UNIV.    0.83           1.00           1.03
EMPLOYEE DENSITY       3.37           4.29           4.27
ZONE   432.             1971           1976           1981
********************************************************
POPULATION             3903.          3657.          3372.
EMPLOYEES              1839.          2092.          2174.
HOUSEHOLDS             1610.          1707.          1748.
ACREAGE                 217.           206.           216.
%TRANSIT-CBD             63.            65.            74.
%TRANSIT-CENTRAL         54.            67.            76.
%TRANSIT-UNIV.           28.            50.            33.
TRANSIT TRIPS-CBD.       41.            22.            32.
TRANSIT TRIPS-CENT.     162.           158.           133.
TRANSIT TRIPS-UNIV.      19.            20.            10.
T.T./100 H.H.-CBD.     2.55           1.29           1.83
T.T./100 H.H.-CENT.   10.06           9.26           7.61
T.T./100 H.H.-UNIV.    1.18           1.17           0.57
EMPLOYEE DENSITY       8.46          10.15          10.07
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ZONE    433.          1971            1976            1981
**********************************************************
POPULATION            1935.           1621.           1491.

EMPLOYEES              682.            757.            839.

HOUSEHOLDS             596.            595.            640.

ACREAGE                137.            136.            138.

%TRANSIT-CBD            53.             41.             42.

%TRANSIT-CENTRAL        49.             42.             43.

%TRANSIT-UNIV.          32.             29.             30.

TRANSIT TRIPS-CBD.       9.              7.              5.

TRANSIT TRIPS-CENT.     59.             40.             30.

TRANSIT TRIPS-UNIV.     17.              7.              7.

T.T./100 H.H.-CBD.    1.51            1.18            0.78

T.T./100 H.H.-CENT.   9.90            6.72            4.69

T.T./100 H.H.-UNIV.   2.85            1.18            1.09

EMPLOYEE DENSITY      4.98            5.55            6.08
ZONE    434.          1971            1976            1981
**********************************************************
POPULATION            2676.           2478.           2211.

EMPLOYEES             1076.           1296.           1376.

HOUSEHOLDS             958.           1040.           1068.

ACREAGE                153.            146.            146.

%TRANSIT-CBD            55.             66.             71.

%TRANSIT-CENTRAL        54.             56.             70.

%TRANSIT-UNIV.          19.             41.             53.

TRANSIT TRIPS-CBD.      23.             21.             12.

TRANSIT TRIPS-CENT.     98.             76.             81.

TRANSIT TRIPS-UNIV.      8.             13.             18.

T.T./100 H.H.-CBD.    2.40            2.02            1.12

T.T./100 H.H.-CENT.  10.23            7.31            7.58

T.T./100 H.H.-UNIV.   0.84            1.25            1.69

EMPLOYEE DENSITY      7.03            8.87            9.45
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ZONE    441.          1971            1976            1981
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POPULATION            592.            541.            461.
EMPLOYEES             205.            261.            235.
HOUSEHOLDS            178.            181.            176.
ACREAGE                54.             55.             53.
%TRANSIT-CBD           -1.             -1.             -1.
%TRANSIT-CENTRAL       30.             46.             35.
%TRANSIT-UNIV.         17.             -1.             13.
TRANSIT TRIPS-CBD.      3.              2.              1.
TRANSIT TRIPS-CENT.     9.             13.              9.
TRANSIT TRIPS-UNIV.     4.              0.              1.
T.T./100 H.H.-CBD.   1.69            1.10            0.57
T.T./100 H.H.-CENT.  5.06            7.18            5.11
T.T./100 H.H.-UNIV.  2.25            0.0             0.57
EMPLOYEE DENSITY     3.77            4.74            4.45
ZONE    442.          1971            1976            1981
*****************************************************************
POPULATION           4487.           5152.           4657.
EMPLOYEES            2262.           2851.           3149.
HOUSEHOLDS           1971.           2734.           2912.
ACREAGE               226.            223.            240.
%TRANSIT-CBD           47.             66.             70.
%TRANSIT-CENTRAL       45.             64.             68.
%TRANSIT-UNIV.         31.             43.             59.
TRANSIT TRIPS-CBD.     53.             42.             51.
TRANSIT TRIPS-CENT.   238.            271.            273.
TRANSIT TRIPS-UNIV.    33.             32.             43.
T.T./100 H.H.-CBD.   2.69            1.54            1.75
T.T./100 H.H.-CENT. 12.08            9.91            9.38
T.T./100 H.H.-UNIV.  1.67            1.17            1.48
EMPLOYEE DENSITY    10.02           12.80           13.12
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ZONE    443.            1971            1976            1981
*************************************************************
POPULATION              802.           1078.            979.
EMPLOYEES               357.            549.            607.
HOUSEHOLDS              473.            688.            681.
ACREAGE                 220.            205.            204.
%TRANSIT-CBD             61.             16.             45.
%TRANSIT-CENTRAL         55.             39.             70.
%TRANSIT-UNIV.           25.             30.             57.
TRANSIT TRIPS-CBD.       19.              3.              9.
TRANSIT TRIPS-CENT.      47.             28.             59.
TRANSIT TRIPS-UNIV.       4.              3.             13.
T.T./100 H.H.-CBD.      4.02            0.44            1.32
T.T./100 H.H.-CENT.     9.94            4.07            8.66
T.T./100 H.H.-UNIV.     0.85            0.44            1.91
EMPLOYEE DENSITY        1.62            2.68            2.97
ZONE    444.            1971            1976            1981
*************************************************************
POPULATION             2733.           3646.           3433.
EMPLOYEES              1482.           2170.           2219.
HOUSEHOLDS             1492.           2278.           2325.
ACREAGE                  60.             59.             60.
%TRANSIT-CBD             51.             51.             68.
%TRANSIT-CENTRAL         48.             56              68.
%TRANSIT-UNIV.           26.             53.             63.
TRANSIT TRIPS-CBD.       69.             28.             21.
TRANSIT TRIPS-CENT.     194.            192.            131.
TRANSIT TRIPS-UNIV.      22.             23.             40.
T.T./100 H.H.-CBD.      4.62            1.23            0.90
T.T./100 H.H.-CENT.    13.00            8.43            5.63
T.T./100 H.H.-UNIV.     1.47            1.01            1.72
EMPLOYEE DENSITY       24.59           36.67           37.11
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ZONE   461.            1971           1976           1981
*********************************************************
POPULATION             2424.          2212.          1908.
EMPLOYEES               792.           980.           926.
HOUSEHOLDS              708.           720.           770.
ACREAGE                 173.           172.           170.
%TRANSIT-CBD             23.            22.            50.
%TRANSIT-CENTRAL         26.            27.            40.
%TRANSIT-UNIV.           19.            59.            28.
TRANSIT TRIPS-CBD.        5.             2.             8.
TRANSIT TRIPS-CENT.      33.            23.            34.
TRANSIT TRIPS-UNIV.       5.            13.             8.
T.T./100 H.H.-CBD.     0.71           0.28           1.04
T.T./100 H.H.-CENT.    4.66           3.19           4.42
T.T./100 H.H.-UNIV.    0.71           1.81           1.04
EMPLOYEE DENSITY       4.57           5.69           5.44
ZONE   462.            1971           1976           1981
*********************************************************
POPULATION             2826.          2590.          2427.
EMPLOYEES              1071.          1183.          1145.
HOUSEHOLDS              829.           852.           930.
ACREAGE                 213.           211.           208.
%TRANSIT-CBD             37.            42.            25.
%TRANSIT-CENTRAL         27.            38.            39.
%TRANSIT-UNIV.            9.            39.            51.
TRANSIT TRIPS-CBD.       20.             8.             2.
TRANSIT TRIPS-CENT.      58.            44.            39.
TRANSIT TRIPS-UNIV.       4.            22.            19.
T.T./100 H.H.-CBD.     2.41           0.94           0.22
T.T./100 H.H.-CENT.    7.00           5.16           4.19
T.T./100 H.H.-UNIV.    0.48           2.58           2.04
EMPLOYEE DENSITY       5.04           5.61           5.51
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ZONE   463.            1971            1976            1981
***********************************************************
POPULATION            3002.           2631.           2518.
EMPLOYEES             1061.           1155.           1377.
HOUSEHOLDS             944.            929.            987.
ACREAGE                240.            239.            243.
%TRANSIT-CBD            43.             27.             43.
%TRANSIT-CENTRAL        35.             37.             45.
%TRANSIT-UNIV.          14.             17.             39.
TRANSIT TRIPS-CBD.      21.              4.              6.
TRANSIT TRIPS-CENT.     66.             36.             55.
TRANSIT TRIPS-UNIV.      5.              5.             14.
T.T./100 H.H.-CBD.    2.22            0.43            0.61
T.T./100 H.H.-CENT.   6.99            3.88            5.57
T.T./100 H.H.-UNIV.   0.53            0.54            1.42
EMPLOYEE DENSITY      4.42            4.83            5.66
ZONE   464.            1971            1976            1981
***********************************************************
POPULATION            3215.           3167.           2754.
EMPLOYEES             1283.           1586.           1417.
HOUSEHOLDS            1073.           1172.           1165.
ACREAGE                300.            299.            307.
%TRANSIT-CBD            29.             33.             22.
%TRANSIT-CENTRAL        24.             38.             31.
%TRANSIT-UNIV.          22.             33.             41.
TRANSIT TRIPS-CBD.      22.             11.              6.
TRANSIT TRIPS-CENT.     64.             71.             51.
TRANSIT TRIPS-UNIV.     16.             21.             22.
T.T./100 H.H.-CBD.    2.05            0.94            0.52
T.T./100 H.H.-CENT.   5.96            6.06            4.38
T.T./100 H.H.-UNIV.   1.49            1.79            1.89
EMPLOYEE DENSITY      4.27            5.31            4.61
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ZONE   465.              1971             1976             1981
***********************************************************************
POPULATION               1003.            1032.             877.
EMPLOYEES                 309.             443.             435.
HOUSEHOLDS                300.             315.             295.
ACREAGE                   253.             215.             215.
%TRANSIT-CBD               27.              23.              17.
%TRANSIT-CENTRAL           21.              23.              16.
%TRANSIT-UNIV.              4.              21.              39.
TRANSIT TRIPS-CBD.          3.               3.               2.
TRANSIT TRIPS-CENT.        10.              13.               9.
TRANSIT TRIPS-UNIV.         1.               4.              12.
T.T./100 H.H.-CBD.        1.00             0.95             0.68
T.T./100 H.H.-CENT.       3.33             4.13             3.05
T.T./100 H.H.-UNIV.       0.33             1.27             4.07
EMPLOYEE DENSITY          1.22             2.06             2.02
ZONE   471.              1971             1976             1981
***********************************************************************
POPULATION               3613.            3085.            2649.
EMPLOYEES                1133.            1317.            1395.
HOUSEHOLDS                865.             870.             883.
ACREAGE                   222.             220.             214.
%TRANSIT-CBD               40.              42.              38.
%TRANSIT-CENTRAL           36.              34.              49.
%TRANSIT-UNIV.             38.              44.              31.
TRANSIT TRIPS-CBD.         14.              10.               6.
TRANSIT TRIPS-CENT.        58.              43.              47.
TRANSIT TRIPS-UNIV.        11.               8.              10.
T.T./100 H.H.-CBD.        1.62             1.15             0.68
T.T./100 H.H.-CENT.       6.71             4.94             5.32
T.T./100 H.H.-UNIV.       1.27             0.92             1.13
EMPLOYEE DENSITY          5.11             6.00             6.51
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ZONE   472.           1971             1976            1981
*****************************************************************
POPULATION           2607.             2263.           1928.

EMPLOYEES             348.              982.           1006.

HOUSEHOLDS            652.              646.            646.

ACREAGE               165.              184.            171.

%TRANSIT-CBD           35.               30.             14.

%TRANSIT-CENTRAL       30.               35.             44.

%TRANSIT-UNIV.         27.               22.             37.

TRANSIT TRIPS-CBD.      7.                3.              1.

TRANSIT TRIPS-CENT.    26                24.             26.

TRANSIT TRIPS-UNIV.     7                 4.              7.

T.T./100 H.H.-CBD.   1.07              0.46            0.15

T.T./100 H.H.-CENT.  3.99              3.72            4.02

T.T./100 H.H.-UNIV.  1.07              0.62            1.08

EMPLOYEE DENSITY     4.55              5.34            5.88
ZONE   473.           1971             1976            1981
*****************************************************************
POPULATION           1398.             1570.           1396.

EMPLOYEES             437.              665.            693.

HOUSEHOLDS            342.              466.            465.

ACREAGE               121.              119.            116.

%TRANSIT-CBD           18.               -1.             -1.

%TRANSIT-CENTRAL       27.               47.             34.

%TRANSIT-UNIV.         10.               -1.             27.

TRANSIT TRIPS-CBD.      2.                4.              2.

TRANSIT TRIPS-CENT.    17.               18.             11.

TRANSIT TRIPS-UNIV.     1.                2.              3.

T.T./100 H.H.-CBD.   0.58              0.86            0.43

T.T./100 H.H.-CENT.  4.97              3.86            2.37

T.T./100 H.H.-UNIV.  0.29              0.43            0.65

EMPLOYEE DENSITY     3.62              5.57            5.95
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ZONE   474.            1971            1976            1981
**********************************************************
POPULATION            2699.           2588.           2736.

EMPLOYEES              901.           1094.           1562.

HOUSEHOLDS             707.            794.           1077.

ACREAGE                184.            183.            225.

%TRANSIT-CBD            33.             13.             64.

%TRANSIT-CENTRAL        34.             37.             65.

%TRANSIT-UNIV.          20.             33.             38.

TRANSIT TRIPS-CBD.       8.              2.              7.

TRANSIT TRIPS-CENT.     34.             20.             45.

TRANSIT TRIPS-UNIV.      3.              4.              6.

T.T./100 H.H.-CBD.     1.13            0.25            0.65

T.T./100 H.H.-CENT.    4.81            2.52            4.18

T.T./100 H.H.-UNIV.    0.42            0.50            0.56

EMPLOYEE DENSITY       4.89            5.98            6.93

ZONE   475.            1971            1976            1981
**********************************************************
POPULATION            2664.           2635.           3522.

EMPLOYEES              856.           1131.           1930.

HOUSEHOLDS             774.            883.           1511.

ACREAGE                184.            181.            214.

%TRANSIT-CBD            45.             47.             44.

%TRANSIT-CENTRAL        43.             50.             53.

%TRANSIT-UNIV.          18.             60.             33.

TRANSIT TRIPS-CBD.       9.              8.              8.

TRANSIT TRIPS-CENT.     43.             45.             70.

TRANSIT TRIPS-UNIV.      3.             15.              7.

T.T./100 H.H.-CBD.     1.16            0.91            0.53

T.T./100 H.H.-CENT.    5.56            5.10            4.63

T.T./100 H.H.-UNIV.    0.39            1.70            0.46

EMPLOYEE DENSITY       4.66            6.24            9.03
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ZONE   486.              1971            1976            1981
********************************************************
POPULATION               973.            3043.           3978.

EMPLOYEES                230.            1225.           2083.

HOUSEHOLDS               261.             891.           1288.

ACREAGE                  181.             225.            380.

%TRANSIT-CBD              -1.              44.             20.

%TRANSIT-CENTRAL          19.              37.             30.

%TRANSIT-UNIV.             5.              26.             33.

TRANSIT TRIPS-CBD.         2.               7.              3.

TRANSIT TRIPS-CENT.        6.              42.             44.

TRANSIT TRIPS-UNIV.        1.               6.             12.

T.T./100 H.H.-CBD.      0.77             0.79            0.23

T.T./100 H.H.-CENT.     2.30             4.71            3.42

T.T./100 H.H.-UNIV.     0.38             0.67            0.93

EMPLOYEE DENSITY        1.27             5.44            5.48

ZONE   491.              1971            1976            1981
********************************************************
POPULATION              1954.            1797.           2261.

EMPLOYEES                760.             853.           1215.

HOUSEHOLDS               546.             585.            800.

ACREAGE                  173.             171.            227.

%TRANSIT-CBD              11.              17.             36.

%TRANSIT-CENTRAL          26.              44.             52.

%TRANSIT-UNIV.            10.              44.             47.

TRANSIT TRIPS-CBD.         2.               1.              5.

TRANSIT TRIPS-CENT.       29.              24.             41.

TRANSIT TRIPS-UNIV.        2.               8.              9.

T.T./100 H.H.-CBD.      0.37             0.17            0.63

T.T./100 H.H.-CENT.     5.31             4.10            5.13

T.T./100 H.H.-UNIV.     0.37             1.37            1.13

EMPLOYEE DENSITY        4.40             4.98            5.36
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ZONE   492.            1971          1976          1981
***********************************************************
POPULATION             2422.         2356.         2393.
EMPLOYEES               785.         1022.         1230.
HOUSEHOLDS              665.          754.          906.
ACREAGE                 183.          180.          222.
%TRANSIT-CBD             26.           65.           -1.
%TRANSIT-CENTRAL         29.           53.           58.
%TRANSIT-UNIV.           11.           54.           33.
TRANSIT TRIPS-CBD.        6.           11.            3.
TRANSIT TRIPS-CENT.      30.           40.           39.
TRANSIT TRIPS-UNIV.       2.           14.            8.
T.T./100 H.H.-CBD.     0.90          1.46          0.33
T.T./100 H.H.-CENT.    4.51          5.31          4.30
T.T./100 H.H.-UNIV.    0.30          1.86          0.88
EMPLOYEE DENSITY       4.30          5.67          5.54
ZONE   493.            1971          1976          1981
***********************************************************
POPULATION             2936.         2647.         2990.
EMPLOYEES               982.         1136.         1738.
HOUSEHOLDS              928.          930.         1383.
ACREAGE                 181.          180.          217.
%TRANSIT-CBD             44.           46.           67.
%TRANSIT-CENTRAL         50.           52.           72.
%TRANSIT-UNIV.           31.           40.           39.
TRANSIT TRIPS-CBD.        8.            6.           14.
TRANSIT TRIPS-CENT.      51.           36.           83.
TRANSIT TRIPS-UNIV.      10.            8.            7.
T.T./100 H.H.-CBD.     0.86          0.65          1.01
T.T./100 H.H.-CENT.    5.50          3.87          6.00
T.T./100 H.H.-UNIV.    1.08          0.86          0.51
EMPLOYEE DENSITY       5.43          6.30          8.01
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ZONE   494.             1971             1976             1981
**************************************************************
POPULATION             3883.            4187.            4036.
EMPLOYEES              1314.            2061.            2083.
HOUSEHOLDS              911.            1273.            1292.
ACREAGE                 289.             286.             282.
%TRANSIT-CBD             28.              50.              43.
%TRANSIT-CENTRAL         22.              36.              48.
%TRANSIT-UNIV.           10.              47.              64.
TRANSIT TRIPS-CBD.       13.              17.               9.
TRANSIT TRIPS-CENT.      51.              82.              79.
TRANSIT TRIPS-UNIV.       8.              30.              41.
T.T./100 H.H.-CBD.     1.43             1.34             0.70
T.T./100 H.H.-CENT.    5.60             6.44             6.11
T.T./100 H.H.-UNIV.    0.88             2.36             3.17
EMPLOYEE DENSITY       4.55             7.20             7.39
ZONE   495.             1971             1976             1981
**************************************************************
POPULATION             4031.            3576.            2956.
EMPLOYEES              1205.            1554.            1648.
HOUSEHOLDS              909.             907.             897.
ACREAGE                 254.             252.             237.
%TRANSIT-CBD             28.              34.              25.
%TRANSIT-CENTRAL         22.              24.              36.
%TRANSIT-UNIV.           17.              36.              57.
TRANSIT TRIPS-CBD.       13.              10.               2.
TRANSIT TRIPS-CENT.      50.              44.              41.
TRANSIT TRIPS-UNIV.       9.              13.              55.
T.T./100 H.H.-CBD.     1.43             1.10             0.22
T.T./100 H.H.-CENT.    5.50             4.85             4.57
T.T./100 H.H.-UNIV.    0.99             1.43             6.13
EMPLOYEE DENSITY       4.75             6.16             6.96
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ZONE   496.              1971           1976           1981
*******************************************************
POPULATION              4511.          3940.          3382.
EMPLOYEES               1402.          1803.          1947.
HOUSEHOLDS              1252.          1283.          1357.
ACREAGE                  299.           296.           259.
%TRANSIT-CBD              51.            53.            52.
%TRANSIT-CENTRAL          30.            47.            53.
%TRANSIT-UNIV.            35.            56.            63.
TRANSIT TRIPS-CBD.        20.            18.            14.
TRANSIT TRIPS-CENT.       56.            67.            75.
TRANSIT TRIPS-UNIV.       23.            23.            30.
T.T./100 H.H.-CBD.       1.60           1.40           1.03
T.T./100 H.H.-CENT.      4.47           5.22           5.53
T.T;/100 H.H.-UNIV.      1.84           1.79           2.21
EMPLOYEE DENSITY         4.69           6.09           7.51
ZONE   501.              1971           1976           1981
*******************************************************
POPULATION              3686.          3500.          1894.
EMPLOYEES               1256.          1617.           923.
HOUSEHOLDS              1024.          1040.           654.
ACREAGE                  340.           338.           229.
%TRANSIT-CBD              11.            21.            37.
%TRANSIT-CENTRAL          16.            19             31.
%TRANSIT-UNIV.            11.            26.             8.
TRANSIT TRIPS-CBD.         6.            10.             7.
TRANSIT TRIPS-CENT.       42.            45.            29.
TRANSIT TRIPS-UNIV.       10.            20.             3.
T.T./100 H.H.-CBD.       0.59           0.96           1.07
T.T./100 H.H.-CENT.      4.10           4.33           4.43
T.T./100 H.H.-UNIV.      0.98           1.92           0.46
EMPLOYEE DENSITY         3.69           4.79           4.03
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ZONE   502.          1971            1976            1981
*********************************************************
POPULATION           1124.           1028.            517.

EMPLOYEES             331.            457.            232.

HOUSEHOLDS            287.            294.            169.

ACREAGE               222.            208.            145.

%TRANSIT-CBD            4.              7.             -1.

%TRANSIT-CENTRAL        4.              9.             30.

%TRANSIT-UNIV.          6.             20.             27.

TRANSIT TRIPS-CBD.      1.              1.              1.

TRANSIT TRIPS-CENT.     3.              5.              7.

TRANSIT TRIPS-UNIV.     3.              9.              4.

T.T./100 H.H.-CBD.   0.35            0.34            0.59

T.T./100 H.H.-CENT.  1.05            1.70            4.14

T.T./100 H.H.-UNIV.  1.05            3.06            2.37

EMPLOYEE DENSITY     1.49            2.20            1.60

ZONE   511.          1971            1976            1981
*********************************************************
POPULATION           5743.           4915.           4425.

EMPLOYEES            1758.           2023.           2240.

HOUSEHOLDS           1365.           1320.           1443.

ACREAGE               348.            346.            337.

%TRANSIT-CBD           31.             23.             12.

%TRANSIT-CENTRAL       28.             32.             33.

%TRANSIT-UNIV.         19.             41.             55.

TRANSIT TRIPS-CBD.     20.              5.              2.

TRANSIT TRIPS-CENT.    73.             73.             59.

TRANSIT TRIPS-UNIV.     8.             20.             28.

T.T./100 H.H.-CBD.   1.47            0.38            0.14

T.T./100 H.H.-CENT.  5.35            5.53            4.09

T.T./100 H.H.-UNIV.  0.59            1.52            1.94

EMPLOYEE DENSITY     5.05            5.85            6.64
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ZONE   512.           1971            1976            1981
**********************************************************
POPULATION            1958.           2681.           2645.

EMPLOYEES              612.           1352.           1581.

HOUSEHOLDS             469.            915.            985.

ACREAGE                171.            163.            152.

%TRANSIT-CBD             0.             22.             36.

%TRANSIT-CENTRAL        10.             36.             44.

%TRANSIT-UNIV.          22.             48.             70.

TRANSIT TRIPS-CBD.       0.              4.              9.

TRANSIT TRIPS-CENT.     12.             54.             62.

TRANSIT TRIPS-UNIV.     11.             23.             49.

T.T./100 H.H.-CBD.    0.0             0.44            0.91

T.T./100 H.H.-CENT.   2.56            5.90            6.29

T.T./100 H.H.-UNIV.   2.35            2.51            4.97

EMPLOYEE DENSITY      3.57            8.29           10.43

ZONE   513.           1971            1976            1981
**********************************************************
POPULATION            1889.           1451.           2329.

EMPLOYEES              587.            636.           1275.

HOUSEHOLDS             488.            416.            772.

ACREAGE                207.            250.            239.

%TRANSIT-CBD            15.             13.             46.

%TRANSIT-CENTRAL        16.             12.             22.

%TRANSIT-UNIV.           9.             36.             61.

TRANSIT TRIPS-CBD.       5.              1.              6.

TRANSIT TRIPS-CENT.     20.              7.             24.

TRANSIT TRIPS-UNIV.      4.              9.             43.

T.T./100 H.H.-CBD.    1.02            0.24            0.78

T.T./100 H.H.-CENT.   4.10            1.68            3.11

T.T./100 H.H.-UNIV.   0.82            2.16            5.57

EMPLOYEE DENSITY      2.83            2.54            5.34
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ZONE   514.                1971             1976              1981
*********** ****************************************************
POPULATION                2172.            1257.             1757.
EMPLOYEES                  641.             502.              941.
HOUSEHOLDS                 502.             322.              506.
ACREAGE                    215.             201.              187.
%TRANSIT-CBD                12.              25.               29.
%TRANSIT-CENTRA.             5.              18.               26.
%TRANSIT-UNIV.               6.              23.               54.
TRANSIT TRIPS-CBD.           5.               3.                5.
TRANSIT TRIPS-CENT.          9.              11.               28.
TRANSIT TRIPS-UNIV           1.               3.               34.
T.T./100 H.H.-CBD.        1.00             0.93              0.99
T.T./100 H.H.-CENT.       1.79             3.42              5.53
T.T./100 H.H.-UNIV.       0.20             0.93              6.72
EMPLOYEE DENSITY          2.98             2.50              5.02
ZONE   593.                1971             1976              1981
****************************************************************
POPULATION                1315.            1616.             1470.
EMPLOYEES                  330.             645.              664.
HOUSEHOLDS                 321.             409.              414.
ACREAGE                    202.             198.              188.
%TRANSIT-CBD                 0.              29.               10.
%TRANSIT-CENTRAL             1.              18.               20.
%TRANSIT-UNIV.              12.              55.               55.
TRANSIT TRIPS-CBD.           0.               4.                1.
TRANSIT TRIPS-CENT.          1.              18.               17.
TRANSIT TRIPS-UNIV.          5.              27.               35.
T.T./100 H.H.-CBD.        0.0              0.98              0.24
T.T./100 H.H.-CENT.       0.31             4.40              4.11
T.T./100 H.H.-UNIV.       1.56             6.60              8.45
EMPLOYEE DENSITY          1.63             3.25              3.53
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ZONE   595.            1971          1976          1981
*******************************************************
POPULATION             822.         1413.         1064.
EMPLOYEES              199.          548.          514.
HOUSEHOLDS             188.          361.          293.
ACREAGE                214.          214.          189.
%TRANSIT-CBD             0.           18.           -1.
%TRANSIT-CENTRAL         4.           21.           12.
%TRANSIT-UNIV.           8.           33.           57.
TRANSIT TRIPS-CBD.       0.            2.            0.
TRANSIT TRIPS-CENT.      2.           10.            7.
TRANSIT TRIPS-UNIV.      2.            9.           30.
T.T./100 H.H.-CBD.     0.0           0.55          0.0
T.T./100 H.H.-CENT.    1.06          2.77          2.39
T.T./100 H.H.-UNIV.    1.06          2.49         10.24
EMPLOYEE DENSITY       0.93          2.56          2.72
ZONE   602.            1971          1976          1981
*******************************************************
POPULATION            1732.         1517.         1366.
EMPLOYEES              509.          688.          692.
HOUSEHOLDS             503.          503.          480.
ACREAGE                205.          232.          215.
%TRANSIT-CBD             0.           -1.           25.
%TRANSIT-CENTRAL        11.           18.           23.
%TRANSIT-UNIV.           1.           -1.            7.
TRANSIT TRIPS-CBD.       0.            0.            2.
TRANSIT TRIPS-CENT.      9.            7.           12.
TRANSIT TRIPS-UNIV.      2.            1.            1.
T.T./100 H.H.-CBD.     0.0           0.0           0.42
T.T./100 H.H.-CENT.    1.79          1.39          2.50
T.T./100 H.H.-UNIV.    0.40          0.20          0.21
EMPLOYEE DENSITY       2.48          2.97          3.22
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ZONE   605.          1971          1976          1981
**********************************************************
POPULATION          3256.         4178.         3780.
EMPLOYEES            936.         3164.         3151.
HOUSEHOLDS          1276.         2013.         2187.
ACREAGE              134.          144.          133.
%TRANSIT-CBD          64.           52.           62.
%TRANSIT-CENTRAL      57.           49.           65.
%TRANSIT-UNIV.         1.            3.           48.
TRANSIT TRIPS-CBD.     9.           11.           18.
TRANSIT TRIPS-CENT.   51.           81.          106.
TRANSIT TRIPS-UNIV.    5.           11.           13.
T.T./100 H.H.-CBD.   0.71          0.55          0.82
T.T./100 H.H.-CENT.  4.00          4.02          4.85
T.T./100 H.H.-UNIV.  0.39          0.55          0.59
EMPLOYEE DENSITY     7.00         22.00         23.72
ZONE   611.          1971          1976          1981
**********************************************************
POPULATION          3402.         2632.         2694.
EMPLOYEES           1142.         1349.         1577.
HOUSEHOLDS          1062.          903.         1076.
ACREAGE              332.          330.          317.
%TRANSIT-CBD          30.           14.           69.
%TRANSIT-CENTRAL      28.           31.           48.
%TRANSIT-UNIV.         9.           10.           36.
TRANSIT TRIPS-CBD.     6.            2.            9.
TRANSIT TRIPS-CENT.   43.           31.           45.
TRANSIT TRIPS-UNIV.   36.           21.           24.
T.T./100 H.H.-CBD.   0.56          0.22          0.84
T.T./100 H.H.-CENT.  4.05          3.43          4.18
T.T./100 H.H.-UNIV.  3.39          2.33          2.23
EMPLOYEE DENSITY     3.44          4.09          4.98
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ZONE   612.            1971              1976              1981
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POPULATION            1553.              886.             1159.
EMPLOYEES              404.              401.              529.
HOUSEHOLDS             354.              235.              311.
ACREAGE                334.              311.              367.
%TRANSIT-CBD            25.               -1.               -1.
%TRANSIT-CENTRAL        11.               16.               20.
%TRANSIT-UNIV.          29.               38.               43.
TRANSIT TRIPS-CBD.       4.                2.                1.
TRANSIT TRIPS-CENT.      9.                5.               10.
TRANSIT TRIPS-UNIV.     34.               15.               33.
T.T./100 H.H.-CBD.     1.13              0.85              0.32
T.T./100 H.H.-CENT.    2.54              2.13              3.22
T.T./100 H.H.-UNIV.    9.60              6.38             10.61
EMPLOYEE DENSITY       1.21              1.29              1.44
ZONE   632.            1971              1976              1981
*******************************************************************
POPULATION            3058.             2478.             2278.
EMPLOYEES             1011.             1174.             1136.
HOUSEHOLDS             785.              737.              745.
ACREAGE                207.              206.              202.
%TRANSIT-CBD            24.               46.               33.
%TRANSIT-CENTRAL        27.               42.               45.
%TRANSIT-UNIV.          29.               49.               65.
TRANSIT TRIPS-CBD.       8.                6.                5.
TRANSIT TRIPS-CENT.     53.               47.               48.
TRANSIT TRIPS-UNIV.     34.               64.               93.
T.T./100 H.H.-CBD.     1.02              0.81              0.67
T.T./100 H.H.-CENT.    6.75              6.38              6.44
T.T./100 H.H.-UNIV.    4.33              8.68             12.48
EMPLOYEE DENSITY       4.89              5.70              5.62
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ZONE   633.              1971              1976              1981
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POPULATION               999.              1747.             1603.
EMPLOYEES                 95.               991.              951.
HOUSEHOLDS               308.               583.              575.
ACREAGE                   51.                59.               59.
%TRANSIT-CBD              -1.                -1.               -1.
%TRANSIT-CENTRAL          45.                33.               46.
%TRANSIT-UNIV.            19.                51.               69.
TRANSIT TRIPS-CBD.         0.                 2.                1.
TRANSIT TRIPS-CENT.        5.                 4.               11.
TRANSIT TRIPS-UNIV.       36.               133.              232.
T.T./100 H.H.-CBD.       0.0                0.34              0.17
T.T./100 H.H.-CENT.      1.62               0.69              1.91
T.T./100 H.H.-UNIV.     11.69              22.81             40.35
EMPLOYEE DENSITY         1.87              16.74             15.99
ZONE   634.              1971              1976              1981
*************************************************************************
POPULATION              2677.              2315.             1955.
EMPLOYEES                788.               938.              995.
HOUSEHOLDS               619.               589.              601.
ACREAGE                  192.               179.              172.
%TRANSIT-CBD               6.                56.               18.
%TRANSIT-CENTRAL          15.                31.               50.
%TRANSIT-UNIV.            23.                48.               54.
TRANSIT TRIPS-CBD.         1.                10.                2.
TRANSIT TRIPS-CENT.       26.                46.               54.
TRANSIT TRIPS-UNIV.       17.                36.               36.
T.T./100 H.H.-CBD.       0.16               1.70              0.33
T.T./100 H.H.-CENT.      4.20               7.81              8.99
T.T./100 H.H.-UNIV.      2.75               6.11              5.99
EMPLOYEE DENSITY         4.11               5.23              5.77
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ZONE 641.	1971	1976	1981
POPULATION	3446.	3651.	3410.
EMPLOYEES	838.	1612.	1849.
HOUSEHOLDS	764.	985.	1093.
ACREAGE	722.	857.	690.
%TRANSIT-CBD	6.	14.	24.
%TRANSIT-CENTRAL	4.	21.	23.
%TRANSIT-UNIV.	22.	32.	45.
TRANSIT TRIPS-CBD.	2.	3.	5.
TRANSIT TRIPS-CENT.	8.	36.	39.
TRANSIT TRIPS-UNIV.	31.	38.	64.
T.T./100 H.H.-CBD.	0.26	0.30	0.46
T.T./100 H.H.-CENT.	1.05	3.65	3.57
T.T./100 H.H.-UNIV.	4.06	3.86	5.86
EMPLOYEE DENSITY	1.16	1.88	2.68

ZONE 651.	1971	1976	1981
POPULATION	4536.	9454.	4156.
EMPLOYEES	1634.	4283.	2296.
HOUSEHOLDS	1253.	2828.	1381.
ACREAGE	309.	309.	300.
%TRANSIT-CBD	16.	47.	60.
%TRANSIT-CENTRAL	13.	41.	52.
%TRANSIT-UNIV.	14.	40.	70.
TRANSIT TRIPS-CBD.	6.	27.	15.
TRANSIT TRIPS-CENT.	28.	214.	86.
TRANSIT TRIPS-UNIV.	26.	133.	107.
T.T./100 H.H.-CBD.	0.48	0.95	1.09
T.T./100 H.H.-CENT.	2.23	7.57	6.23
T.T./100 H.H.-UNIV.	2.08	4.70	7.75
EMPLOYEE DENSITY	5.28	13.84	7.65

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ZONE   652.             1971          1976          1981
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POPULATION              1711.         5225.         4743.
EMPLOYEES                567.         2490.         2622.
HOUSEHOLDS               419.         1705.         1566.
ACREAGE                  375.          393.          357.
%TRANSIT-CBD              29.           26.           44.
%TRANSIT-CENTRAL          19.           33.           48.
%TRANSIT-UNIV.             8.           31.           42.
TRANSIT TRIPS-CBD.         4.           10.           14.
TRANSIT TRIPS-CENT.       14.           84.          118.
TRANSIT TRIPS-UNIV.        5.           52.           57.
T.T./100 H.H.-CBD.      0.95          0.59          0.89
T.T./100 H.H.-CENT.     3.34          4.93          7.54
T.T./100 H.H.-UNIV.     1.19          3.05          3.64
EMPLOYEE DENSITY        1.51          6.34          7.35
ZONE   653.             1971          1976          1981
*********************************************************
POPULATION               511.         3370.         2265.
EMPLOYEES                 81.         1411.         1094.
HOUSEHOLDS               108.         1010.          691.
ACREAGE                  188.          255.          203.
%TRANSIT-CBD              -1.           55.           67.
%TRANSIT-CENTRAL          67.           42.           46.
%TRANSIT-UNIV.            -1.           46.           57.
TRANSIT TRIPS-CBD.         4.           12.            8.
TRANSIT TRIPS-CENT.       12.           57.           34.
TRANSIT TRIPS-UNIV.        2.           30.           31.
T.T./100 H.H.-CBD.      3.70          1.19          1.16
T.T./100 H.H.-CENT.    11.11          5.64          4.92
T.T./100 H.H.-UNIV.     1.85          2.97          4.49
EMPLOYEE DENSITY        0.43          5.53          5.39
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ZONE   654.              1971            1976            1981
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POPULATION              5022.           9813.           5181.
EMPLOYEES               1426.           3876.           2595.
HOUSEHOLDS              1156.           2411.           1407.
ACREAGE                  359.            384.            371.
%TRANSIT-CBD              18.             25.             28.
%TRANSIT-CENTRAL          19.             33.             36.
%TRANSIT-UNIV.            19.             25.             44.
TRANSIT TRIPS-CBD.         9.             17.              7.
TRANSIT TRIPS-CENT.       54.            196.             95.
TRANSIT TRIPS-UNIV.       28.             64.             85.
T.T./100 H.H.-CBD.      0.78            0.71            0.50
T.T./100 H.H.-CENT.     4.67            8.13            6.75
T.T./100 H.H.-UNIV.     2.42            2.65            6.04
EMPLOYEE DENSITY        3.97           10.09            6.99
ZONE   681.              1971            1976            1981
**************************************************************
POPULATION              3022.           5178.           2933.
EMPLOYEES               1181.           2725.           1630.
HOUSEHOLDS               906.           1869.           1289.
ACREAGE                  228.            226.            221.
%TRANSIT-CBD              43.             45.             46.
%TRANSIT-CENTRAL          33.             51.             58.
%TRANSIT-UNIV.            26.             38.             69.
TRANSIT TRIPS-CBD.        12.             14.              6.
TRANSIT TRIPS-CENT.       59.            108.             57.
TRANSIT TRIPS-UNIV.       31.             48.             81.
T.T./100 H.H.-CBD.      1.32            0.75            0.47
T.T./100 H.H.-CENT.     6.51            5.78            4.42
T.T./100 H.H.-UNIV.     3.42            2.57            6.28
EMPLOYEE DENSITY        5.18           12.06            7.38
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ZONE 682.	1971	1976	1981
POPULATION	2703.	3854.	1763.
EMPLOYEES	903.	1800.	860.
HOUSEHOLDS	675.	1194.	566.
ACREAGE	163.	162.	164.
%TRANSIT-CBD	43.	36.	-1.
%TRANSIT-CENTRAL	30.	42.	39.
%TRANSIT-UNIV.	22.	25.	56.
TRANSIT TRIPS-CBD.	6.	8.	3.
TRANSIT TRIPS-CENT.	25.	49.	16.
TRANSIT TRIPS-UNIV.	15.	13.	27.
T.T./100 H.H.-CBD.	0.89	0.67	0.53
T.T./100 H.H.-CENT.	3.70	4.10	2.83
T.T./100 H.H.-UNIV.	2.22	1.09	4.77
EMPLOYEE DENSITY	5.53	11.08	5.24

ZONE 684.	1971	1976	1981
POPULATION	2015.	1791.	4082.
EMPLOYEES	604.	746.	2302.
HOUSEHOLDS	500.	643.	1830.
ACREAGE	156.	137.	173.
%TRANSIT-CBD	13.	25.	42.
%TRANSIT-CENTRAL	25.	43.	50.
%TRANSIT-UNIV.	15.	30.	64.
TRANSIT TRIPS-CBD.	1.	4.	8.
TRANSIT TRIPS-CENT.	15.	37.	84.
TRANSIT TRIPS-UNIV.	8.	18.	103.
T.T./100 H.H.-CBD.	0.20	0.62	0.44
T.T./100 H.H.-CENT.	3.00	5.75	4.59
T.T./100 H.H.-UNIV.	1.60	2.80	5.63
EMPLOYEE DENSITY	3.87	5.44	13.31

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ZONE   691.              1971            1976            1981
*************************************************************
POPULATION              3905.           2026.           3289.
EMPLOYEES               1385.           1158.           2100.
HOUSEHOLDS              1424.            756.           1612.
ACREAGE                  223.            221.            227.
%TRANSIT-CBD              70.             -1.             80.
%TRANSIT-CENTRAL          48.             48.             59.
%TRANSIT-UNIV.             3.              6.             22.
TRANSIT TRIPS-CBD.        16.              5.             12.
TRANSIT TRIPS-CENT.       82.             29.             47.
TRANSIT TRIPS-UNIV.       14.              8.             11.
T.T./100 H.H.-CBD.      1.12            0.66            0.74
T.T./100 H.H.-CENT.     5.76            3.84            2.92
T.T./100 H.H.-UNIV.     0.98            1.06            0.68
EMPLOYEE DENSITY        6.21            5.25            9.27
ZONE   692.              1971            1976            1981
*************************************************************
POPULATION              4753.           3671.           4220.
EMPLOYEES               1927.           2207.           2916.
HOUSEHOLDS              1936.           1719.           2439.
ACREAGE                  248.            247.            249.
%TRANSIT-CBD              61.             70.             69.
%TRANSIT-CENTRAL          56.             65.             71.
%TRANSIT-UNIV.            24.             27.             55.
TRANSIT TRIPS-CBD.        23.             28.             24.
TRANSIT TRIPS-CENT.      124.            113.            166.
TRANSIT TRIPS-UNIV.       89.             59.             66.
T.T./100 H.H.-CBD.      1.19            1.63            0.98
T.T./100 H.H.-CENT.     6.40            6.57            6.81
T.T./100 H.H.-UNIV.     4.60            3.43            2.71
EMPLOYEE DENSITY        7.76            8.94           11.72
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ZONE   694.              1971             1976            1981
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POPULATION              2362.            2121.           2001.

EMPLOYEES                878.            1055.           1142.

HOUSEHOLDS               779.             835.            929.

ACREAGE                  143.             141.            145.

%TRANSIT-CBD              56.              54.             73.

%TRANSIT-CENTRAL          51.              55.             64.

%TRANSIT-UNIV.            29.              40.             60.

TRANSIT TRIPS-CBD.        10.              15.              8.

TRANSIT TRIPS-CENT.       58.              51.             35.

TRANSIT TRIPS-UNIV.       20.              32.             37.

T.T./100 H.H.-CBD.      1.28             1.80            0.86

T.T./100 H.H.-CENT.     7.45             6.11            3.77

T.T./100 H.H.-UNIV.     2.57             3.83            3.98

EMPLOYEE DENSITY        6.14             7.49            7.90

ZONE   702.              1971             1976            1981
***************************************************************
POPULATION              4397.            4446.           3876.

EMPLOYEES               2101.            3230.           2990.

HOUSEHOLDS              2043.            2430.           2408.

ACREAGE                  170.             186.            167.

%TRANSIT-CBD              52.              46.             66.

%TRANSIT-CENTRAL          49.              49.             65.

%TRANSIT-UNIV.             7.               8.             56.

TRANSIT TRIPS-CBD.        31.              25.             23.

TRANSIT TRIPS-CENT.      131.             141.            159.

TRANSIT TRIPS-UNIV.       44.              39.             45.

T.T./100 H.H.-CBD.      1.52             1.03            0.96

T.T./100 H.H.-CENT.     6.41             5.80            6.60

T.T./100 H.H.-UNIV.     2.15             1.60            1.87

EMPLOYEE DENSITY       12.34            17.35           17.90
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